AERIAL SURVEYS OF MIGRATORY BIRDS ON THE FRASER RIVER DELTA, 1989-90

R.W. McKelvey
K.R. Summers

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ABSTRACT

The results of 16 aerial surveys over the estuary of the Fraser River between mid October 1989 and mid January 1990 are presented. The numbers seen were compared to those summarized for 1966-74, 1982-83 and 1983-84 by McKelvey et al (1985). The annual estimate of dabbling duck use of the whole estuary (Boundary Bay and the Fraser River delta) was significantly lower than those seen in 1966-74 and 1982-83 but not significantly different from those seen in 1983-84. Mean total numbers of gulls were within the ranges of those seen previously. Waterfowl counts were highly variable between surveys. Comparisons with mid-winter waterfowl counts from the Pacific flyway indicated that the downward trend seen on the Fraser River estuary was similar to that seen elsewhere on the Pacific coast. The efficacy of aerial survey techniques was discussed. It was concluded that such techniques will allow an adequate level of population monitoring, but that some simple improvements in observer calibration may be usefull.

RESUME

Le rapport donne les résultats de 16 levés aériens effectués au-dessus de l'estuaire de fleuve Fraser entre la mi-octobre 1989 et la mi-janvier 1990. Ces chifres ont été comparés à ceux de 1966-1974, de 1982-1983 et de 1983-1984 rapportés par McKelvey et al. (1985). L'évaluation annuelle de la répartition des canards de surface sur tout l'estuaire (la baie Boundary et le delta du Fraser) était de beaucoup inférieure à celle de 1966-1974 et de 1982-1983, mais sensiblement la même qu'en 1983-1984. Le nombre moyen total de mouettes était dans la même échelle que les relevés précédents. Le nombre d'oiseaux aquatiques variait énormément d'un levé à l'autre. Des comparaisons avec les dénombrements d'oiseaux aquatiques au milieu de l'hiver sur la route de migration du Pacifique démontrement que la tendance à la baisse remarquée dans l'estuaire du Fraser était semblable à cette notée ailleurs sur la côte de Pacifique. L'efficacité des techniques de levés aériens a été discutée. La conclusion est que ces techniques permettent une observation adéquate des populations, mais qu'il serait utile d'apporter des améliorations très simples dans le calibrage d'observation.

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INTRODUCTION

The delta and estuary of the Fraser River, British Columbia (Fig. 1), is one of the most important wintering habitats for migratory birds in Canada (Taylor 1970; Cooperative Waterfowl Management Plan for British Columbia [CWMPBC] 1983). It is also adjacent to a large and growing human population which has resulted in the loss of considerable amounts of wetland habitat. Because of these two factors, efforts have been made over the years to monitor trends in abundance of certain groups of birds wintering on the estuary, especially waterfowl.

The present study is part of a program to build on the base of existing information. The intention is to monitor long term trends of waterfowl populations wintering in Boundary Bay and on the Fraser River foreshore, or collectively, the Fraser River estuary. The results of surveys in 1989-90 are presented in this report, and compared with those seen between 1966-74, 1982-83 and 1983-84 as reported by McKelvey et al. (1985). Trends are also compared with those of the Pacific flyway midwinter waterfowl survey (Bartonek 1990). Species compositions will be reported elsewhere.

METHODS

Between October 1989 and January 1990, 16 aerial surveys to count waterfowl were flown over the Fraser River estuary, following the shoreline route used by McKelvey et al. (1985) (Fig 1). The survey dates and number of replicate counts per day for each area are shown in Table 1. Replicate counts could not always be conducted over and north of Lulu Island, due to restrictions imposed by Air Traffic Control at Vancouver International Airport. Generally, at least three estimates were obtained per day over other parts of the route.

The survey was timed to coincide with the waterfowl hunting season in southern British Columbia, in the belief that most ducks would tend to be located on the foreshore during the day, rather than dispersed throughout adjacent farmland. This was based on Jury (1981) and the personal observations

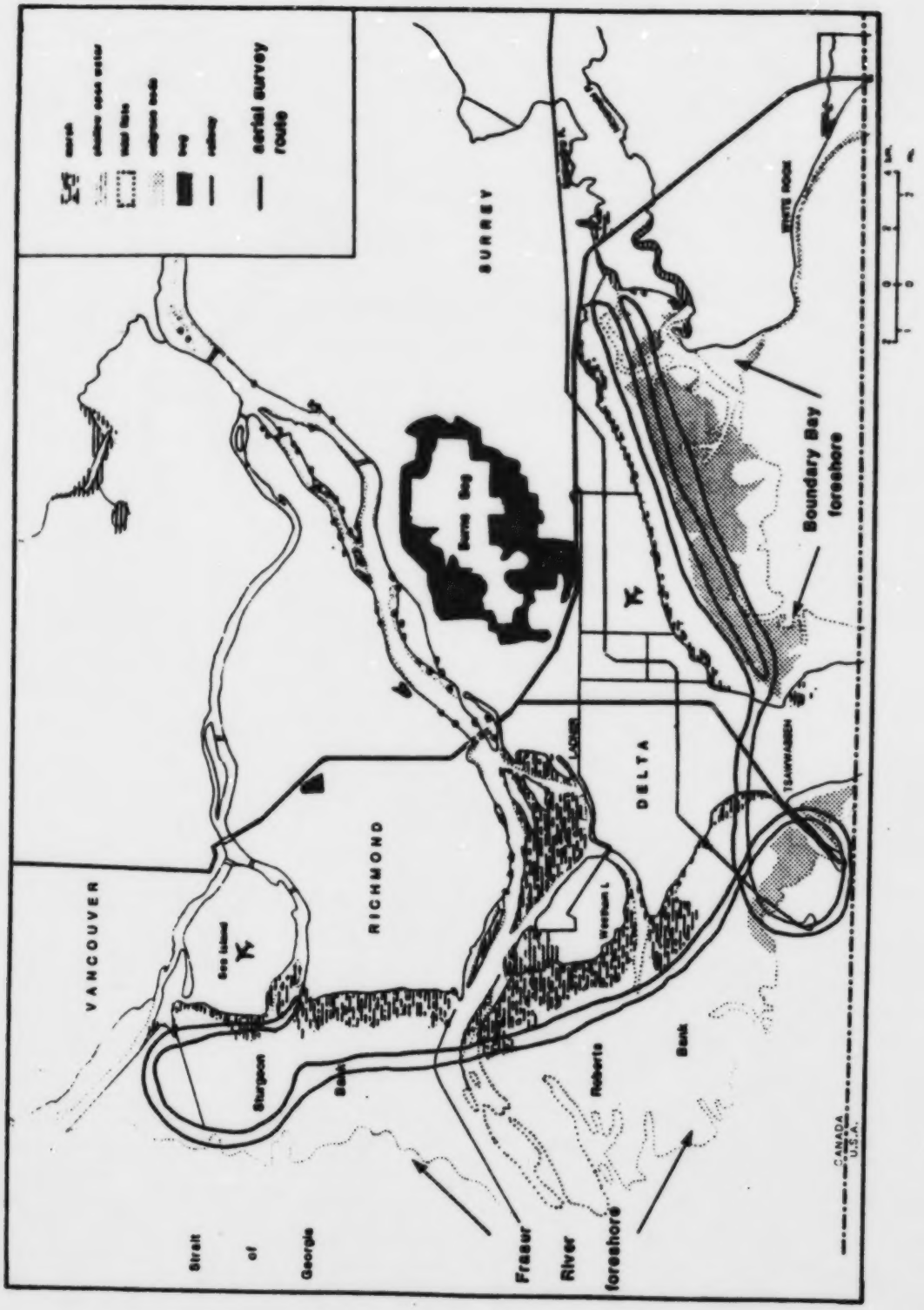

Figure 1. Fraser River delta study area and the location of aerial survey routes, 1989-90.

of the authors, discussions with biologists from Ducks Unlimited Canada and the British Columbia Wildlife Branch, and with federal and provincial game officers familiar with patterns of hunter-use of the area.

The survey procedure was identical to that used by McKelvey et al (1985). Observers sat on either side of the aircraft and recorded their observations into a tape recorder. Counts from both sides of the aircraft were used to determine the numbers of birds present from all locations except Boundary Bay. There, because of the large numbers of birds usually present, the aircraft was positioned to give one observer at a time the best view. The other observer kept track of the location and recorded any large flocks of birds that were unavoidably encountered on that side of the aircraft. Subsequent replicate counts were made by alternate observers. Location was recorded by noting the ends of the streets running at right angles to the foreshore dikes. A tide height of approximately 11 ft at Pt. Atkinson dictated the preferred survey period. That height had been found to give the best concentration of ducks by McKelvey et al. (1985) for aerial survey. Higher or lower tides tended to cause unpredictable dispersion of the birds, making number estimations more difficult.

Data were analyzed in the following way. Each replicate count for any particular day was treated as an estimate of the number of birds present on that day. The mean and standard error were calculated, and the mean used as the final estimate for that day. Monthly means were then calculated from the daily mean estimates, to allow comparisons with other data also expressing estimates by month (eg. McKelvey et al. (1985)). Monthly standard errors were calculated using the method described in McKelvey et al. 1985:15.

In order to facilitate trend comparisons between years the monthly means were added together to give an annual total. This is analogous to measuring the area under the curve of a graph of bird numbers versus time, and gives a measure of bird use-days. There are two advantages to using such a number. (1) Bird numbers on an area such as the Fraser River delta are very dynamic. The birds move from place to place very quickly, between days and throughout the winter season, in response to weather, food and disturbance. Numbers fluctuate seasonally to such an extent that a calculated mean number of birds present

throughout the season will have an inherently large standard deviation, making between-year comparisons very difficult. Using bird use-days over comes this problem because the precision of that estimate is high in comparison to the population standard deviation. (2) Many other coastal mid-winter surveys make a population estimate at only one time of the year, when it is assumed that the population is stable and all the birds are actually counted. Whether or not that is true remains to be seen but a single winter data point in any survey facilitates plotting of annual trends, the main purpose in such surveys.

All comparisons between means were performed by calculating the value of Z, or the normal deviate (Zar 1974:74). A Z-test is used to determine the probability of two means being different when it is difficult to determine how many degrees of freedom are present. That was the case in this study when monthly means were added to produce the annual estimate of bird use. With a Z-test probability can be expressed liberally as significant at the .05 level or conservatively, using multiple range tests, as .05/n, where n is the number of comparisons being made.

Table 1. Dates and number of replicate counts per day of waterfowl surveys in Boundary Bay and the Fraser River foreshore, 1989-90.

Date	Transect location						
	Sea I	Mid Arm	Lulu I	West I	Brun Pt	Rob Bk	B Bay
16 Oct 1989	1	1	1	3	3	3	3
20 Oct	1	1	1	3	3	3	1
27 Oct	1	1	3	3	3	3	3
6 Nov	1	1	2	3	3	3	3
11 Nov	1	1	1	3	3	3	3
13 Nov	1	1	3	3	3	3	3
17 Nov	1	1	1	3	3	3	3
21 Nov	2	1	2	3	3	3	3
24 Nov	1	1	1	3	3	3	3
4 Dec	2	1	2	2	2	2	1
8 Dec	2	1	2	2	2	2	4
15 Dec	1	1	3	3	3	3	3
22 Dec	1	1	1	3	3	3	3
2 Jan 1990	1	1	3	3	3	3	3
8 Jan	2	1	3	3	3	3	3
12 Jan	2	2	3	2	3	3	3

RESULTS

Weather

In the 1989-90 count period the weather was characterized by above normal temperatures and precipitation, and below normal sunshine hours and wind speed (Table 2). In general, the weather was wet and warm but not particularly stormy, and there was relatively little weather cold enough to result in foreshore icing. Weather can affect the distribution of birds as well as the ability of aerial observers to count them. Freezing weather in particular can cause problems, if ice builds up on the foreshore.

Table 2. Weather conditions on the Fraser River estuary in 1989-90 compared with long-term averages.

Variable	Month	1971-80 Average	Normals 1951-80	1989-90
Mean temp range (°C)	O	5.3 - 13.9	6.4 - 13.6	7.2 - 13.8
	N	2.1 - 8.8	2.8 - 9.0	4.3 - 9.6
	D	0.6 - 6.3	1.2 - 6.5	2.6 - 7.3
	J	-1.1 - 4.9	-0.2 - 5.6	1.7 - 7.0
Precip. (cm)	O	82.0	114.0	96.4
	N	142.0	150.1	213.1
	D	151.0	182.4	133.9
	J	95.0	153.8	192.8
Sunshine (hrs)	O	132.1	121.0	118.1
	N	69.6	69.3	60.5
	D	53.1	47.9	47.2
	J	62.1	53.5	53.2
Wind speed (km/h)	O	18.0	11.2	11.2
	N	20.7	12.2	12.2
	D	22.9	13.0	13.0
	J	19.9	12.2	10.7

Data from Atmospheric Environment Service, Environment Canada, Vancouver.

Seasonal Bird Numbers

Duck numbers in Boundary Bay peaked in December while those on the Fraser River foreshore peaked in October (Table 3). In previous surveys the peak numbers have been seen in November or January on Boundary Bay and in November or December on the Fraser River foreshore. Boundary Bay continued to receive the most dabbling duck use with the majority of that use occurring between Beach Grove and the Boundary Bay airport. However, large numbers were often observed continuously distributed along the shoreline to 112th Street. Most of the Fraser River foreshore birds occurred between the Tsawwassen and Roberts Bank causeways (Table 4; details of daily and monthly summaries in Appendices 1 and 2).

Table 3. Mean number of dabbling ducks (in thousands) seen per month on aerial surveys of the Fraser River estuary from 1966-74 to 1989-90.

Month (n)	Location			
	Boundary Bay		Fraser Foreshore	
	Mean	SE	Mean	SE
Oct/66-74 (13)	18.3	0.5	28.5	0.9
/82 (2)	28.9	4.5	28.3	5.9
/83 (4)	24.3	2.7	19.8	1.6
/85 (1)	25.4		26.0	
/89 (3)	20.0	2.4	22.3	2.5
Nov/66-74 (11)	39.3	5.9	40.3	7.8
/82 (5)	37.9	6.4	28.7	4.3
/83 (5)	30.0	3.2	22.9	4.8
/89 (6)	24.5	1.9	14.5	1.5
Dec/66-74 (8)	31.4	2.3	35.1	6.5
/82 (4)	33.6	3.0	37.4	6.7
/83 (3)	22.7	1.0	14.9	2.0
/89 (4)	33.5	3.8	11.1	2.5
Jan/66-74 (6)	10.7	5.7	17.1	5.9
/83 (5)	29.9	4.2	20.9	6.5
/84 (3)	31.5	7.7	16.5	1.7
/86 (1)	15.7		34.7	
/89 (3)	23.9	0.9	11.7	1.0

(n) is sample size; annual peak counts shown underlined.

Table 4. Annual total number of dabbling ducks (in thousands) seen on aerial surveys of the Fraser River foreshore, and the relative importance of each area, since 1966-74.

Area	Survey Period							
	1966-74	%	1982-83	%	1983-84	%	1989-90	%
Sea Island	22.6	18.7	22.6	19.6	7.0	9.5	3.7	6.3
River Mouth	ND[1]		1.1	0.9	1.2	1.6	0.3	0.5
Lulu Island	15.0	12.4	8.1	7.1	4.8	6.5	9.1	15.3
Westham Is.	53.8	44.5	18.4	16.0	4.3	5.8	6.5	10.9
Brunswick Pt.	29.6	24.5	24.4	21.2	16.8	22.7	3.9	6.6
Roberts Bank	ND[1]		48.6	35.2	40.0	54.0	36.0	60.4

1 River Mouth data probably included in Sea Island or Lulu Island; Roberts Bank probably not distinguished from Brunswick Point, prior to causeway construction.

Gulls were seen in largest number in December on Boundary Bay, and in January on the Fraser River foreshore in 1989-90 (Table 5). Peak counts in the past have occurred in October and December on Boundary Bay and in November or December on the Fraser River foreshore. Gull numbers on Boundary Bay were much higher than on the Fraser River foreshore. Most birds were seen loafing intertidally at low tide, particularly later in the afternoon when they had finished feeding at the sanitary land fill in Burns Bog.

Annual Comparison of Numbers

Annual measurements of dabbling duck and gull use are shown in Table 6 for 1966-74, 1982-83, 1983-84 and 1989-90. These data are shown graphically in Figures 2 to 7. Statistical comparisons of the number birds seen per month between years is summarized in Appendix 3. Dabbling duck use of the Fraser River foreshore has declined by 50% from the peak counts recorded in 1966-74. Duck use of Boundary Bay has declined by 22% since peak use in 1982-83. Gull numbers on the Fraser River foreshore have declined by 32% since 1982-83, and by 28% since 1983-84 on Boundary Bay.

Table 5. Mean number of gulls seen per month on aerial surveys of the Fraser River estuary, 1989-90.

Month (n)	Location			
	Boundary Bay		Fraser Foreshore	
	Mean	SE	Mean	SE
Oct/82 (2)	1168	828	28	23.3
/83 (4)	4939	3075	644	106
/85 (1)	382		158	
/89 (3)	1332	418	395	171
Nov/82 (5)	498	194	221	116
/83 (5)	348	305	236	23.7
/89 (6)	870	459	121	50.0
Dec/82 (4)	1419	1121	1006	402
/83 (3)	1507	669	667	173
/89 (4)	2309	774	432	80.9
Jan/83 (5)	143	637	867	319
/84 (3)	2261	1193	500	54.8
/86 (1)	2590		433	
/90 (3)	1957	808	494	211

(n) is sample size; peak counts in bold.

The number of dabbling ducks seen in Boundary Bay was significantly lower in 1989-90 than in 1982-83 and in 1983-84 but not from that recorded in 1966-74 (Table 7). McKelvey et al (1985) recorded a statistically significant difference between 1982-83 and 1983-84 for ducks and gulls at both Boundary Bay and the Fraser River foreshore. During the present analysis, no significance was detected between these same years for dabblers at Boundary Bay and gulls at either location. There are two reasons why these differences now do not appear to be statistically significant when tested again. First, only data for the months October to January were included from the 1982-84 data, instead of September to April, because of the shorter survey period in 1989-90. Second, the original data were not available for 1982-83 so tests had to be done using summarized data (monthly means), making comparison tests less powerful.

Table 6. Annual estimates of bird use by dabbling ducks and gulls seen between October and January on Boundary Bay, the Fraser River foreshore and the Fraser River estuary, 1966-74 and 1989-90. Values are ± 2 standard errors.

Year	Dabbling Ducks (thousands)			Gulls		
	Foreshore	Boundary Bay	Estuary	Foreshore	Boundary Bay	Estuary
1966-74 (n=4)[1]	121.0 (±4.63)	99.7 (±7.0)	220.7 (±30.0)	-	-	-
1982-83 (n=4)	115.3 (±23.8)	130.3 (±18.8)	245.6 (±30.4)	2122 (±1054)	3228 (±1545)	5350 (±3264)
1983-84 (n=4)	74.1 (±11.4)	108.5 (±28.2)	182.6 (±30.4)	2047 (±424)	9055 (±6758)	11102 (±6772)
1989-90 (n=4)	59.6 (±8.0)	101.9 (±10.0)	161.5 (±12.8)	1442 (±576)	6468 (±2560)	7910 (±2624)

[1] n is the number of monthly means used in the comparison.

The number of dabbling ducks seen on the Fraser River foreshore in 1989-90 was significantly different from those seen in all previous surveys. Combining the data from Boundary Bay and the Fraser River foreshore showed that total numbers of dabbling ducks on the Fraser River estuary were not significantly different from those seen in 1983-84 but were from those seen in 1982-83 or 1966-74 (Table 7).

Boundary Bay had the lowest numbers of dabbling ducks recorded for three of the four survey months in 1989-90, compared to previous surveys. The exception was December when almost the highest number was seen. However, December 1989 had comparatively the lowest count for the Fraser River foreshore. When monthly mean counts from Boundary Bay were compared, these differences are not statistically significant using the conservative multiple range test (Appendix 3).

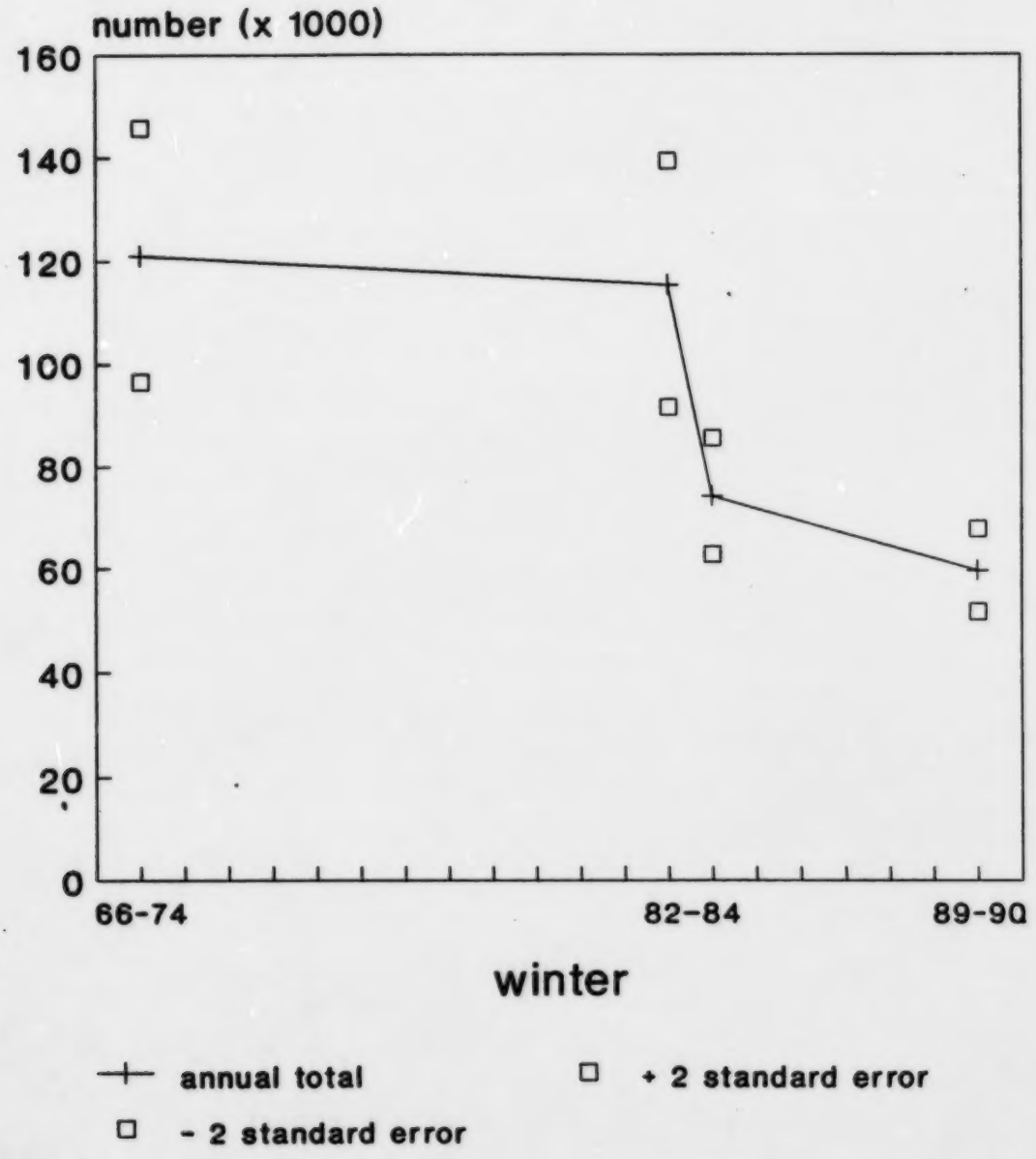

Figure 2. Annual total number of dabbling ducks seen per winter on aerial surveys of the Fraser River foreshore, 1966-74 to 1989-90.

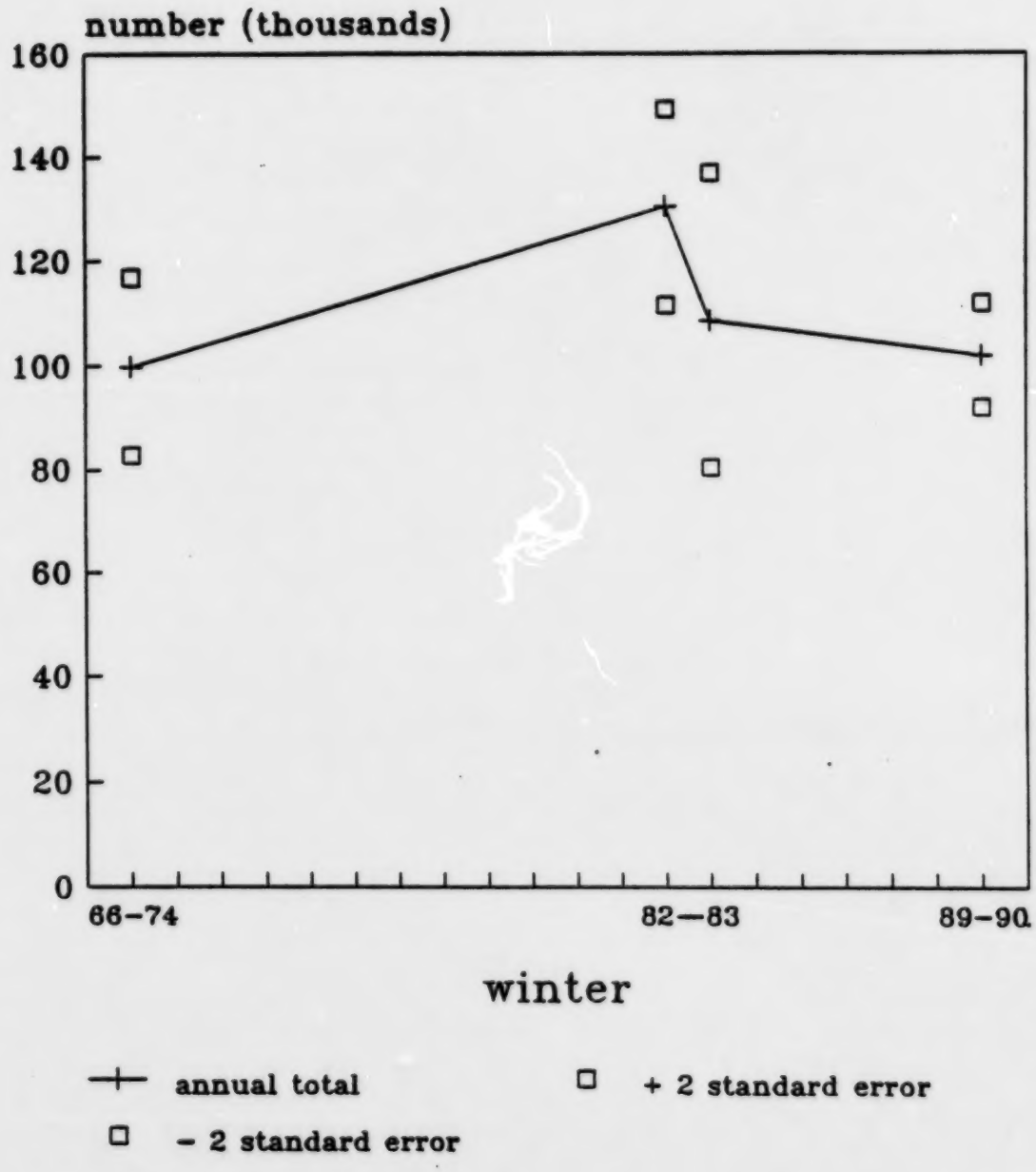

Figure 3. Annual total number of dabbling ducks seen per winter on aerial surveys of Boundary Bay, 1966-74 to 1989-90.

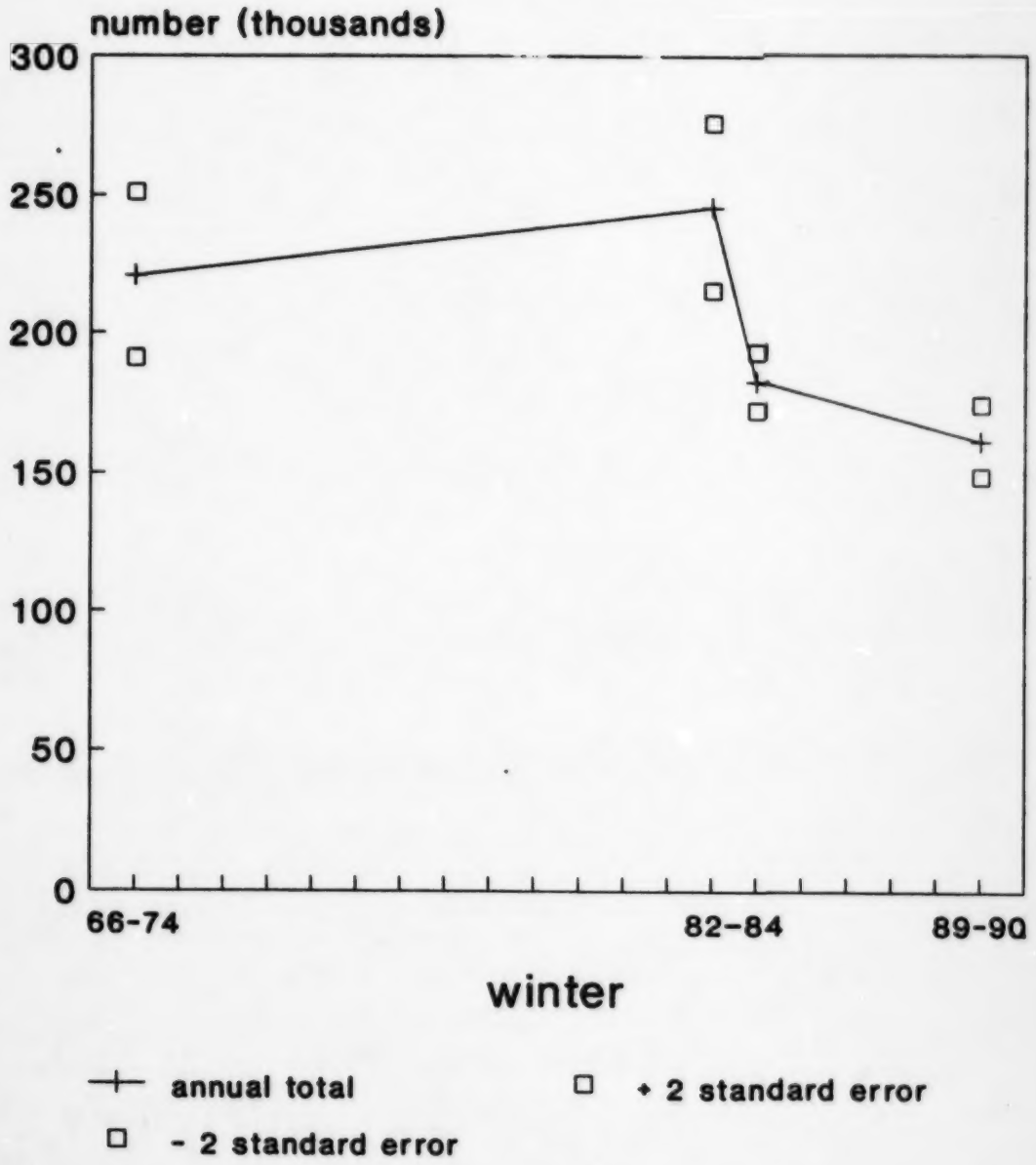

Figure 4. Annual total number of dabbling ducks seen per winter on aerial surveys of the Fraser River estuary, 1966-74 to 1989-90.

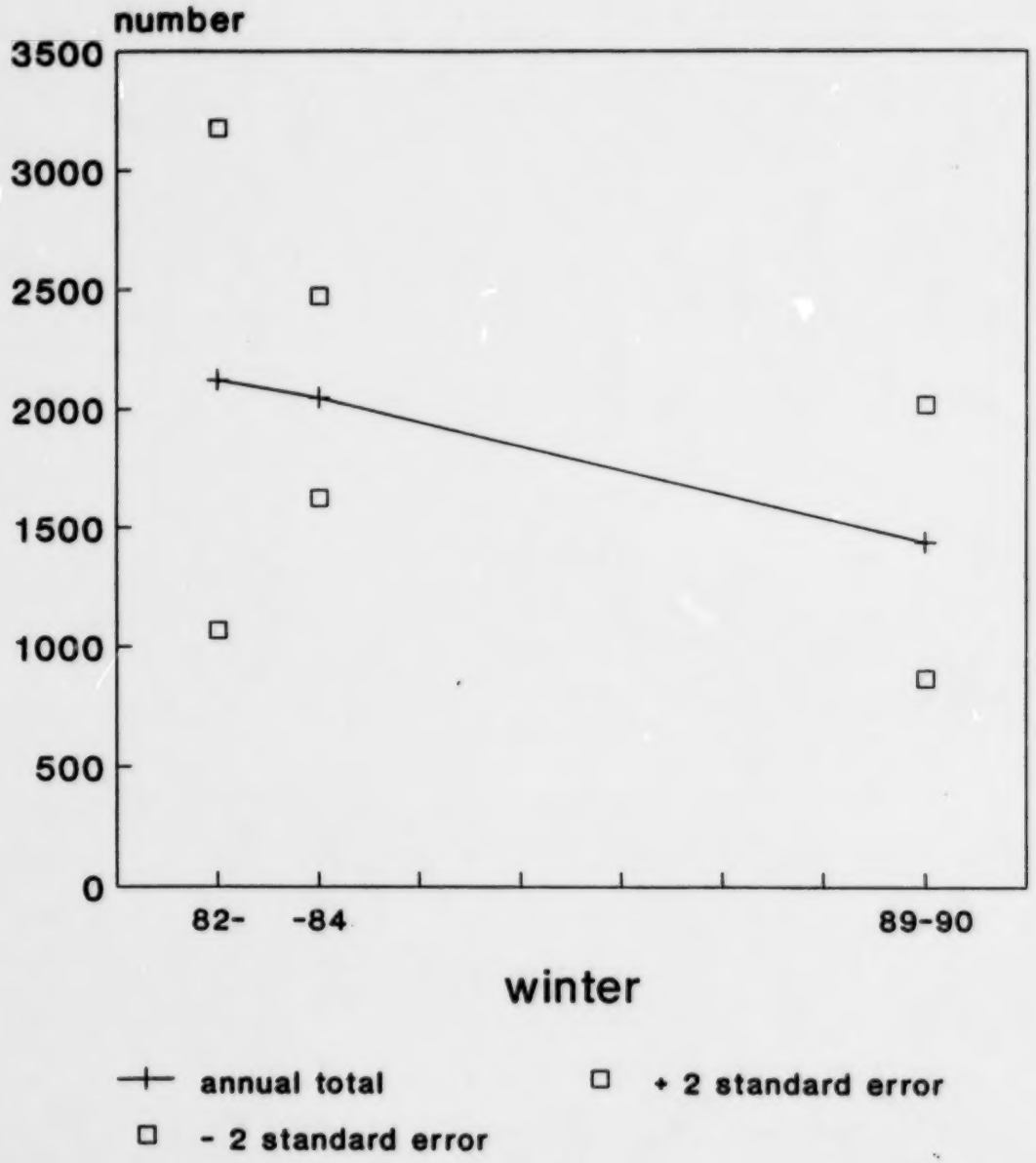

Figure 5. Annual total number of gulls seen per winter on aerial surveys of the Fraser River foreshore, 1982-83 to 198-90.

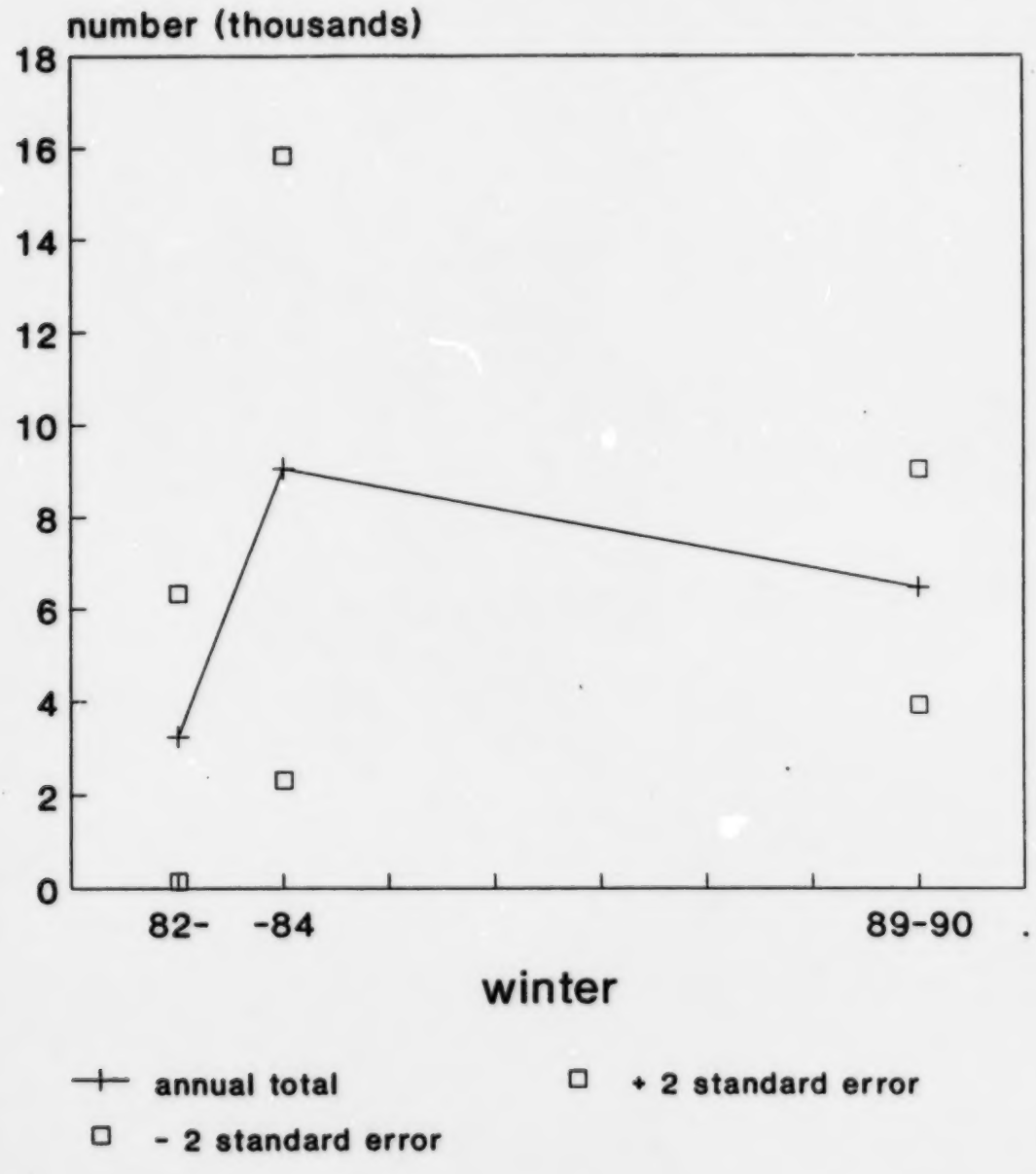

Figure 6. Annual total number of gulls seen per winter on aerial surveys of Boundary Bay, 1982-83 to 1989-90.

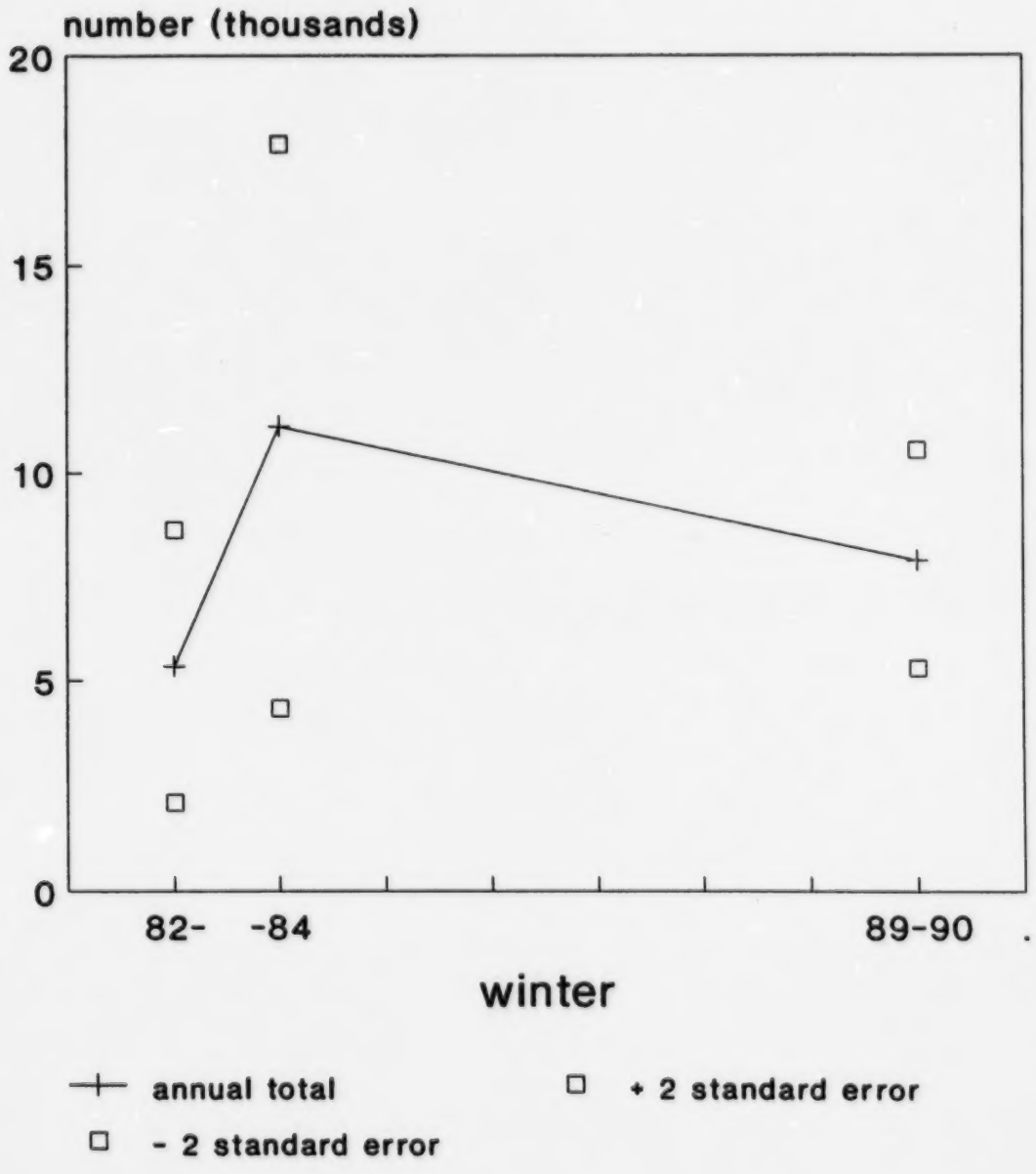

Figure 7. Annual total number of gulls seen per winter on aerial surveys of the Fraser River estuary, 1982-83 to 1989-90

Table 7. Probability values resulting from Z-test comparisons of annual numbers of birds seen (Oct - Jan) between years for Boundary Bay, the Fraser River foreshore and the Fraser River estuary.

	Boundary Bay			Fraser River foreshore			Fraser River estuary		
	probability of being the same								
Dabbling Ducks									
	1966-74	1982-83	1983-84	1966-74	1982-83	1983-84	1966-74	1982-83	1983-84
1982-83	.016	-		.741	-		.242	-	
1983-84	.596	.121	-	.001	.002	-	.075	.033	-
1989-90	.826	.001	.038	<.001	.001	.038	.012	<.001	.201
Gulls									
		1982-83	1983-84		1982-83	1983-84		1982-83	1983-84
1983-84		.116			.897			.126	
1989-90		.107	.472		.258	.091		.224	.379

Monthly mean numbers of dabbling ducks on the Fraser River foreshore in 1989-90 also tended to be lower than those recorded previously, except in November, when they were closer to the norm. As in Boundary Bay these differences were not statistically significant using multiple range tests (Appendix 3).

Overall, the low seasonal numbers in 1989-90 for the whole estuary (Table 7) were primarily the result of the low numbers recorded in November and January (Table 3). When comparing the difference between annual means for all years the Fraser River foreshore had the strongest differences (four out of six multiple range comparisons), Boundary Bay had the weakest differences (one out of six multiple range comparisons) and the combined data were in between (two out of six multiple range comparisons) (Appendix 3 and Table 6).

A comparison of Fraser River estuary counts with Pacific flyway mid-winter counts indicates downward trends in both populations (Figure 8). The flyway trend is significant at about $P = 0.85$ and that of the Fraser River estuary at $P = 0.81$.

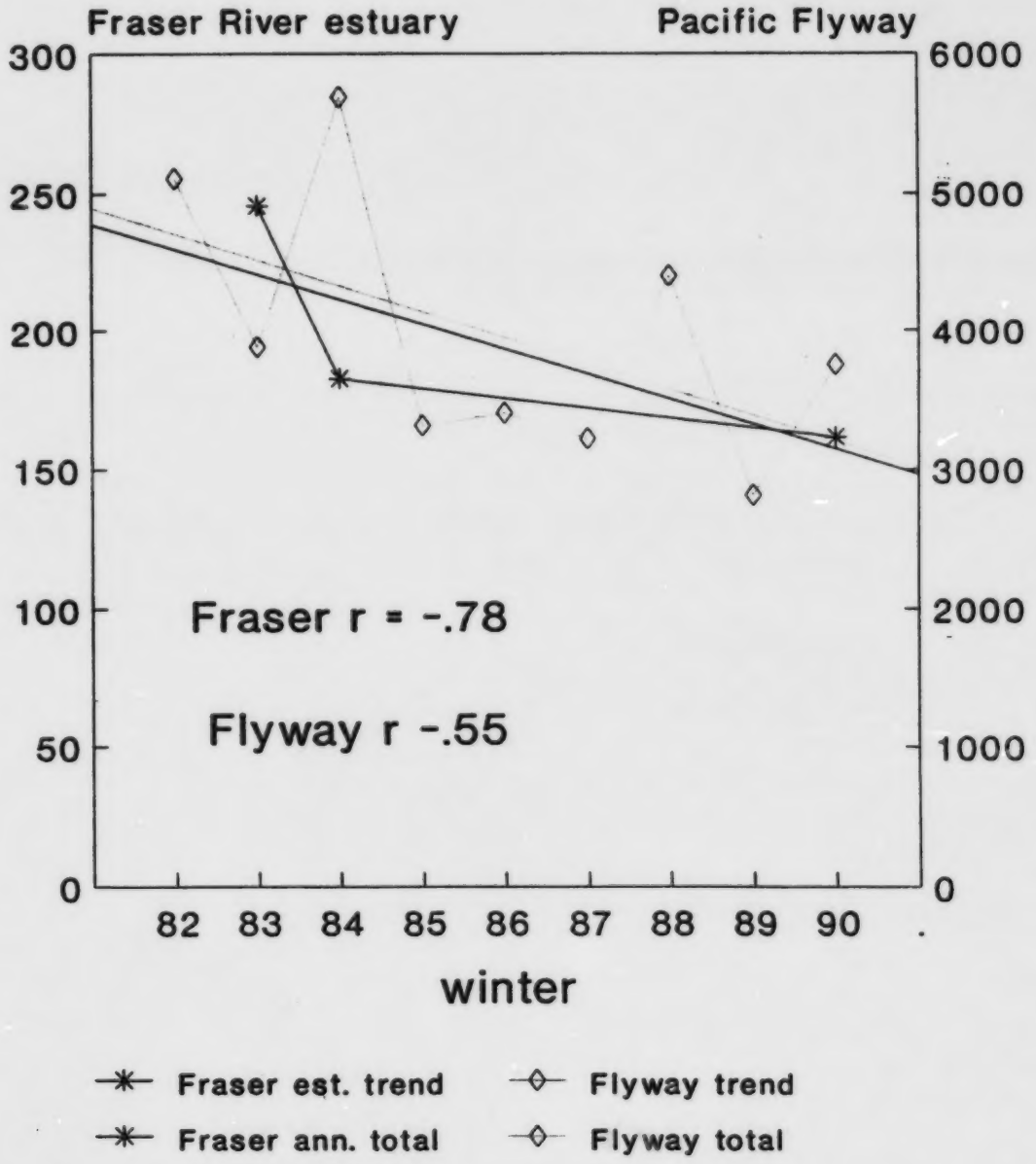

Figure 8. Dabbling duck counts on the Fraser River estuary compared to mid-winter Pacific Flyway counts between 1982 and 1990.

Gull numbers fluctuated more dramatically from year to year than did dabbling ducks (Table 6). On the whole, however, numbers were within the ranges seen on earlier surveys. When comparing 1989-90 with 1982-83 and 1983-84, there was only one significant multiple range difference between months for either Boundary Bay or the Fraser River foreshore (Appendix 3). Between years, the annual rates of use of Boundary Bay, the Fraser River foreshore and the Fraser River estuary were not significantly different.

DISCUSSION

Population Trends

The downward trend in total bird use of the Fraser River estuary is at least in keeping with trends in continental duck populations, which have declined substantially in the last 10 years (Reynolds et al.). It is difficult to determine, however, if the downward trend is due solely to declining continental populations, or if it is compounded in some way by population changes peculiar to the Fraser River estuary. Changes in seasonal distribution would seem to indicate that local conditions, such as habitat quantity and quality, might also be affecting bird use.

If winter waterfowl population size is dependent on the amount of upland available, for example, then relative distribution might at least be expected to change as upland use changed. This might also be reflected by the size of the populations using the adjacent foreshore, if it can be assumed that those populations are the ones using the nearest uplands (see Tamisier 1976).

Because so much of Richmond has been converted from farmland, the largest relative change might be expected on the Lulu Island foreshore. Lulu Island did show a decline in use until 1989-90, but then there was a slight increase in relative use. Roberts Bank on the other hand, continually increased in importance, while Brunswick Point has dropped off, after a period of relative stability. Because little change in land-use has occurred behind Roberts Bank, Brunswick Point or Westham Island, trends in population distribution would not appear to be reflecting changing land-use very well.

The relative distribution on the Fraser River foreshore might not be as important as the relative use of the total Fraser River foreshore compared to that of Boundary Bay. Since 1966-74 Boundary Bay has increased from 45% of the total use to 63%, while total popuations have declined by 38%. Land-use changes have not been nearly as rapid near Boundary Bay as at Lulu Island. Perhaps the Fraser River should be considered as one unit, rather than several, because of its estuarine character as opposed to the salt marsh character of Boundary Bay. The nature of Roberts Bank has probably also changed over the years, as the effect of the causeways has been felt. Eelgrass is now very abundant, as it is in Boundary Bay. That area may be developing into a more salt-marsh-like environment, as a result of the causeways excluding the Fraser River plume. At any rate the two more saline areas, Boundary Bay and Roberts Bank, are now getting more relative use than in the past.

Changes in seasonal abundance may also implicate land-use changes as being partly responsible for observed changes in population distribution. An examination of the results of tests of monthly differences (Appendix 3) indicated that between year variations were largely the result of differences in the November and December observations. The monthly trend in 1989-90 on the Fraser River foreshore followed that of other years except that October rather than November had the highest number of birds. This may mean that the foreshore is more important to birds migrating through the ares than it is to wintering birds. Migrants may tend not to use uplands, and have therefore been relatively little impacted by changes on those uplands. If wintering birds prefer to roost in close proximity to prefered feeding areas, such as uplands, then fewer birds in the winter period might be expected near upland areas that have been removed from agricultural production. The apparent increase in relative importance of Boundary Bay and Roberts Bank may reflect a disappearance of some birds from the delta, close to areas where uplands have changed, rather than a relocation to the above two areas.

Although the trends in numbers recorded on the Fraser River estuary and the Pacific flyway are not significant at the traditional level of statistical importance, the trends should have meaning for waterfowl managers. The trends indicate that there is between an 80% to 85% chance of there being a real

decline. Management in the conservative sense, i.e. action in favour of the resource, should be undertaken at this level of probability. Waiting for better odds would be unwise, given the dynamics of the popuation involved, and the limited resources available for conservation in general.

Survey Methods

Some concern has been voiced about the usefulness of aerial surveys in monitoring waterfowl populations, and a few words in defense of the methods used in this study seem appropriate. Aerial surveyors generally do not have the time to count individual birds, so some form of estimation must be employed. That would be a disadvantage if an absolute census was the objective. But in an area such as the Fraser River estuary, where wintering and migrating bird populations are highly dynamic, the best that can be hoped for is an estimation of numbers, an assessment of annual bird use, and a monitoring of trends in that use over time. Although estimating numbers of birds in flocks requires some assumptions, as long as those assumptions remain constant, the estimated population will approximate the real world, and thus allow monitoring of the trends.

The main assumptions of the technique are that (1) surveyors are consistent in the error of their estimates and (2) this error is similar in each surveyor. Although these assumptions were not rigorously tested during this study some measure of consistency was ensured by constant reference to pictures of rice grains and navy beans, the numbers of which were known and checked against the estimates. Because no calibration existed for previous studies, none was obtained for this study, which may have been a shortcoming. Future surveys should allow sufficient resources to deal with this problem.

In some cases ground surveys may be more accurate than aerial surveys. However, when the numbers of birds present are large, ground surveys suffer from the same general technical problems as do aerial surveys. The exception might be that more time may be available for individual estimates. That in turn can cause problems if bird distribution changes. To our knowledge ground surveys on the Fraser River estuary are seldom if ever replicated, so their precision is usually not known. The only certain way to determine the size of

large flocks is photographically.

Complications also arise, in evaluating techniques, if one is not aware of how small the Fraser River estuary sampling unit is, compared to the total potential range of the birds being studied. Birds apparently move rapidly from one area of the estuary to another, within the time interval of one survey, and between surveys. They may also move out of the estuary in cold weather and return when the weather moderates. This results in a bird population that, when one wishes to know the average number of birds present over a certain time period, will be characterized by a high standard deviation. Repeated frequent attempts to determine what the population size is, however, will result in reasonably precise estimates of what that "instantaneous" population is. For example, monthly estimates of population size in this study had standard errors of about 10% of the mean.

Because there is great apparent daily and seasonal variation in the numbers of birds present on the Fraser River estuary, some method of expressing annual numbers present must be employed. The mean annual number of birds seen would not be useful, hence the use of the sum of the monthly means, expressed over time as bird use. This figure is fairly precise because the daily and monthly estimates are precise. A more precise estimate could be obtained by doing more surveys.

Weather, tide and human disturbance can also affect population size and distribution. In this study the influence of abiotic factors was reduced as much as possible by flying under reasonably similar weather conditions and at fairly consistent tide levels. The human element was addressed by flying during the season when hunting disturbance was thought to keep most of the birds on intertidal areas, based on our previous experiences, and Jury (1981). Even though some use of fields may take place during hunting season, presumably if surveys are conducted at the same relative time and under the same relative conditions each year, the relative distribution of the birds should be the same. Trends should logically be concluded to reflect the real world. Should hunting pressure decline markedly however, or even disappear, the assumption of constant relative distribution may have to be reconsidered.

Other factors can affect the variability of counts versus the actual numbers present. These include the location of the aircraft when flying over or around large flocks (birds too far, or obscured under aircraft), altitude, bird visibility (colour and location), and light conditions. Of these variables, altitude was generally consistent, and some measure of general variability due to flock location was obtained by making two to four consecutive counts within a short time span.

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APPENDIX 1

Daily summaries of numbers of birds seen by species groups, on each transect, for each survey.

Daily mean numbers of birds recorded at Boundary Bay during 1989/90 aerial censuses.

DABBLERS

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	3	17198	3434	14034	20850
89/10/20	1	18085	.	18085	18085
89/10/27	3	24853	4276	21523	29675
89/11/06	3	25094	7987	16423	32150
89/11/11	3	33202	6439	26735	39613
89/11/13	3	19733	7655	13840	28385
89/11/17	3	21292	2861	18075	23550
89/11/21	3	25335	635.2	24947	26068
89/11/24	3	23808	6214	16640	27655
89/12/04	1	30560	.	30560	30560
89/12/08	4	39994	2299	36725	41971
89/12/15	3	39707	4318	35300	43930
89/12/22	3	24272	3409	20735	27536
90/01/02	3	23191	1758	21167	24335
90/01/08	3	22746	2054	21560	25118
90/01/12	3	25637	1499	24101	27097

DIVING DUCKS

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	3	300	264.6	0	500
89/10/20	1	0	.	0	0
89/10/27	3	3459	5156	175	9402
89/11/06	3	844	198.5	654	1050
89/11/11	3	3850	2869	550	5750
89/11/13	3	2650	2534	0	5050
89/11/17	3	927	726.1	276	1710
89/11/21	3	1138	985.5	172	2142
89/11/24	3	658.7	447.0	165	1036
89/12/04	1	2	.	2	2
89/12/08	4	1056	769.4	231	1905
89/12/15	3	164.3	80.35	80	240
89/12/22	3	593.3	724.6	3	1402
90/01/02	3	385	211.9	181	604
90/01/08	3	648.3	436.5	355	1150
90/01/12	3	1212	280.4	889	1396

TOTAL DUCKS

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	3	17498	3427	14534	21250
89/10/20	1	18085	.	18085	18085
89/10/27	3	28312	3635	24161	30925
89/11/06	3	25938	7935	17251	32804
89/11/11	3	37052	7255	31985	45363
89/11/13	3	22383	5831	16740	28385
89/11/17	3	22219	3355	18351	24345
89/11/21	3	26473	1136	25162	27168
89/11/24	3	24467	5881	17676	27905
89/12/04	1	30562	.	30562	30562
89/12/08	4	41051	1979	38630	43448
89/12/15	3	39871	4367	35380	44103
89/12/22	3	24866	2900	22137	27911
90/01/02	3	23576	1929	21348	24705
90/01/08	3	23394	1915	21915	25558
90/01/12	3	26848	1536	25451	28493

SNOW GEESE

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	3	7753	13420	0	23259
89/10/20	1	0	.	0	0
89/10/27	3	0	0	0	0
89/11/06	3	0	0	0	0
89/11/11	3	0	0	0	0
89/11/13	3	0	0	0	0
89/11/17	3	0	0	0	0
89/11/21	3	0	0	0	0
89/11/24	3	0	0	0	0
89/12/04	1	0	.	0	0
89/12/08	4	0	0	0	0
89/12/15	3	0	0	0	0
89/12/22	3	0	0	0	0
90/01/02	3	0	0	0	0
90/01/08	3	0	0	0	0
90/01/12	3	0	0	0	0

TOTAL GEESE

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	3	0	0	0	0
89/10/20	1	0	.	0	0
89/10/27	3	0	0	0	0
89/11/06	3	0	0	0	0
89/11/11	3	0	0	0	0
89/11/13	3	0	0	0	0
89/11/17	3	0	0	0	0
89/11/21	3	0	0	0	0
89/11/24	3	0	0	0	0
89/12/04	1	0	.	0	0
89/12/08	4	0	0	0	0
89/12/15	3	0	0	0	0
89/12/22	3	0	0	0	0
90/01/02	3	30	26.46	0	50
90/01/08	3	3.333	5.774	0	10
90/01/12	3	0	0	0	0

SWANS

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	3	0	0	0	0
89/10/20	1	0	.	0	0
89/10/27	3	11.67	2.082	10	14
89/11/06	3	0	0	0	0
89/11/11	3	21.67	2.887	20	25
89/11/13	3	3.333	2.887	0	5
89/11/17	3	12.33	10.97	0	21
89/11/21	3	0	0	0	0
89/11/24	3	.3333	.5774	0	1
89/12/04	1	0	.	0	0
89/12/08	4	0	0	0	0
89/12/15	3	0	0	0	0
89/12/22	3	.6667	.5774	0	1
90/01/02	3	0	0	0	0
90/01/08	3	0	0	0	0
90/01/12	3	0	0	0	0

WATERFOWL

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	3	17498	3427	14534	21250
89/10/20	1	18085	.	18085	18085
89/10/27	3	28324	3635	24172	30935
89/11/06	3	25938	7935	17251	32804
89/11/11	3	37073	7254	32005	45383
89/11/13	3	22387	5828	16745	28385
89/11/17	3	22231	3348	18372	24361
89/11/21	3	26473	1136	25162	27168
89/11/24	3	24467	5882	17676	27905
89/12/04	1	30562	.	30562	30562
89/12/08	4	41051	1979	38630	43448
89/12/15	3	39871	4367	35380	44103
89/12/22	3	24866	2900	22137	27912
90/01/02	3	23606	1912	21398	24745
90/01/08	3	23398	1921	21915	25568
90/01/12	3	26848	1536	25451	28493

SHOREBIRDS

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	3	200	346.4	0	600
89/10/20	1	2000	.	2000	2000
89/10/27	3	14155	12480	300	24515
89/11/06	3	333.3	577.4	0	1000
89/11/11	3	5667	8690	500	15700
89/11/13	3	12000	6083	5000	16000
89/11/17	3	500	866.0	0	1500
89/11/21	3	3208	2060	1675	5550
89/11/24	3	8380	5798	5015	15075
89/12/04	1	5200	.	5200	5200
89/12/08	4	19734	16664	1035	37000
89/12/15	3	19787	9466	8860	25500
89/12/22	3	13837	6663	6500	19510
90/01/02	3	2367	2259	0	4500
90/01/08	3	818.3	741.3	0	1445
90/01/12	3	3917	2983	1500	7250

GULLS

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	3	1914	695.3	1499	2717
89/10/20	1	520	.	520	520
89/10/27	3	1562	86.23	1463	1618
89/11/06	3	66.67	57.84	22	132
89/11/11	3	274	58.03	208	317
89/11/13	3	195.7	10.21	184	203
89/11/17	3	2440	1332	1428	3949
89/11/21	3	2190	1123	1333	3461
89/11/24	3	51	11.14	41	63
89/12/04	1	1830	.	1830	1830
89/12/08	4	528	350.1	115	908
89/12/15	3	4229	625.3	3806	4947
89/12/22	3	2648	303.4	2327	2930
90/01/02	3	3402	748.8	2768	4228
90/01/08	3	606.3	93.72	543	714
90/01/12	3	1863	353	1456	2090

DIVERS (loons, grebes cormorants)

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	3	.3333	.5774	0	1
89/10/20	1	0	.	0	0
89/10/27	3	0	0	0	0
89/11/06	3	1.333	1.528	0	3
89/11/11	3	.6667	1.155	0	2
89/11/13	3	0	0	0	0
89/11/17	3	19.67	7.372	11	25
89/11/21	3	.3333	.5774	0	1
89/11/24	3	2	2.646	0	5
89/12/04	1	6	.	6	6
89/12/08	4	33	5.888	27	41
89/12/15	3	15.67	17.79	0	35
89/12/22	3	63.67	70.69	17	145
90/01/02	3	9.333	1.155	8	10
90/01/08	3	13	12.77	2	27
90/01/12	3	4	1.732	3	6

TOTAL BIRDS without SHOREBIRDS

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	3	19588	3593	16078	23258
89/10/20	1	18605	.	18605	18605
89/10/27	3	29904	3720	25657	32584
89/11/06	3	26007	7879	17383	32830
89/11/11	3	37684	6992	32327	45594
89/11/13	3	22582	5830	16945	28588
89/11/17	3	24692	2081	22346	26316
89/11/21	3	28669	183.6	28512	28871
89/11/24	3	24520	5888	17722	27955
89/12/04	1	32400	.	32400	32400
89/12/08	4	41616	2105	39050	44201
89/12/15	3	44118	3877	40327	48076
89/12/22	3	27581	2717	24841	30275
90/01/02	3	27019	2214	24620	28984
90/01/08	3	24017	2007	22468	26285
90/01/12	3	28716	1599	27547	30538

TOTAL BIRDS

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	3	19788	3305	16678	23258
89/10/20	1	20605	.	20605	20605
89/10/27	3	44060	12680	31772	57099
89/11/06	3	26340	8321	17383	33830
89/11/11	3	43018	15846	33127	61294
89/11/13	3	34582	2302	32945	37214
89/11/17	3	25192	2483	22346	26915
89/11/21	3	31878	1998	30546	34175
89/11/24	3	32900	91.28	32797	32970
89/12/04	1	37600	.	37600	37600
89/12/08	4	61350	16473	42518	76050
89/12/15	3	63905	12874	49187	73076
89/12/22	3	41417	7885	34126	49785
90/01/02	3	29386	3551	27220	33484
90/01/08	3	24836	2670	22468	27730
90/01/12	3	32633	2438	30547	35313

Daily mean numbers of birds recorded at **Sea Island** during 1989/90 aerial censuses.

DABBLERS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	1535	.	1535	1535
89/10/20	1	2175	.	2175	2175
89/10/27	1	890	.	890	890
89/11/06	1	400	.	400	400
89/11/11	1	1280	.	1280	1280
89/11/13	1	645	.	645	645
89/11/17	1	1093	.	1093	1093
89/11/21	2	951.5	103.9	878	1025
89/11/24	1	545	.	545	545
89/12/04	2	365	91.92	300	430
89/12/08	2	1388	53.03	1350	1425
89/12/15	1	985	.	985	985
89/12/22	1	571	.	571	571
90/01/02	1	432	.	432	432
90/01/08	2	290	91.92	225	355
90/01/12	2	964	263	778	1150

DIVING DUCKS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	200	.	200	200
89/10/20	1	0	.	0	0
89/10/27	1	4	.	4	4
89/11/06	1	0	.	0	0
89/11/11	1	200	.	200	200
89/11/13	1	300	.	300	300
89/11/17	1	0	.	0	0
89/11/21	2	0	0	0	0
89/11/24	1	0	.	0	0
89/12/04	2	200	282.8	0	400
89/12/08	2	155.5	218.5	1	310
89/12/15	1	4	.	4	4
89/12/22	1	0	.	0	0
90/01/02	1	12	.	12	12
90/01/08	2	37.5	53.03	0	75
90/01/12	2	62.5	88.39	0	125

TOTAL DUCKS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	1735	.	1735	1735
89/10/20	1	2175	.	2175	2175
89/10/27	1	894	.	894	894
89/11/06	1	400	.	400	400
89/11/11	1	1480	.	1480	1480
89/11/13	1	945	.	945	945
89/11/17	1	1093	.	1093	1093
89/11/21	2	951.5	103.9	878	1025
89/11/24	1	545	.	545	545
89/12/04	2	565	190.9	430	700
89/12/08	2	1543	271.5	1351	1735
89/12/15	1	989	.	989	989
89/12/22	1	571	.	571	571
90/01/02	1	444	.	444	444
90/01/08	2	327.5	145	225	430
90/01/12	2	1027	351.4	778	1275

SNOW GEESE

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	300	.	300	300
89/10/20	1	500	.	500	500
89/10/27	1	1600	.	1600	1600
89/11/06	1	3000	.	3000	3000
89/11/11	1	1000	.	1000	1000
89/11/13	1	250	.	250	250
89/11/17	1	3	.	3	3
89/11/21	2	0	0	0	0
89/11/24	1	0	.	0	0
89/12/04	2	0	0	0	0
89/12/08	2	0	0	0	0
89/12/15	1	30	.	30	30
89/12/22	1	0	.	0	0
90/01/02	1	0	.	0	0
90/01/08	2	0	0	0	0
90/01/12	2	0	0	0	0

TOTAL GEESE

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	300	.	300	300
89/10/20	1	500	.	500	500
89/10/27	1	1600	.	1600	1600
89/11/06	1	3000	.	3000	3000
89/11/11	1	1000	.	1000	1000
89/11/13	1	250	.	250	250
89/11/17	1	3	.	3	3
89/11/21	2	0	0	0	0
89/11/24	1	0	.	0	0
89/12/04	2	0	0	0	0
89/12/08	2	0	0	0	0
89/12/15	1	30	.	30	30
89/12/22	1	0	.	0	0
90/01/02	1	75	.	75	75
90/01/08	2	56.5	26.16	38	75
90/01/12	2	75	106.1	0	150

SWANS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	0	.	0	0
89/10/20	1	0	.	0	0
89/10/27	1	0	.	0	0
89/11/06	1	0	.	0	0
89/11/11	1	0	.	0	0
89/11/13	1	0	.	0	0
89/11/17	1	0	.	0	0
89/11/21	2	0	0	0	0
89/11/24	1	0	.	0	0
89/12/04	2	0	0	0	0
89/12/08	2	0	0	0	0
89/12/15	1	0	.	0	0
89/12/22	1	0	.	0	0
90/01/02	1	0	.	0	0
90/01/08	2	0	0	0	0
90/01/12	2	0	0	0	0

WATERFOWL

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	2035	.	2035	2035
89/10/20	1	2675	.	2675	2675
89/10/27	1	2494	.	2494	2494
89/11/06	1	3400	.	3400	3400
89/11/11	1	2480	.	2480	2480
89/11/13	1	1195	.	1195	1195
89/11/17	1	1096	.	1096	1096
89/11/21	2	951.5	103.9	878	1025
89/11/24	1	545	.	545	545
89/12/04	2	565	190.9	430	700
89/12/08	2	1543	271.5	1351	1735
89/12/15	1	1019	.	1019	1019
89/12/22	1	571	.	571	571
90/01/02	1	519	.	519	519
90/01/08	2	384	171.1	263	505
90/01/12	2	1102	457.5	778	1425

SHOREBIRDS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	50	.	50	50
89/10/20	1	0	.	0	0
89/10/27	1	0	.	0	0
89/11/06	1	0	.	0	0
89/11/11	1	1000	.	1000	1000
89/11/13	1	0	.	0	0
89/11/17	1	100	.	100	100
89/11/21	2	0	0	0	0
89/11/24	1	0	.	0	0
89/12/04	2	0	0	0	0
89/12/08	2	0	0	0	0
89/12/15	1	0	.	0	0
89/12/22	1	0	.	0	0
90/01/02	1	0	.	0	0
90/01/08	2	0	0	0	0
90/01/12	2	500	707.1	0	1000

GULLS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	0	.	0	0
89/10/20	1	5	.	5	5
89/10/27	1	42	.	42	42
89/11/06	1	7	.	7	7
89/11/11	1	0	.	0	0
89/11/13	1	10	.	10	10
89/11/17	1	4	.	4	4
89/11/21	2	1.5	2.121	0	3
89/11/24	1	4	.	4	4
89/12/04	2	39.5	14.85	29	50
89/12/08	2	.5	.7071	0	1
89/12/15	1	0	.	0	0
89/12/22	1	2	.	2	2
90/01/02	1	122	.	122	122
90/01/08	2	4.5	.7071	4	5
90/01/12	2	54	4.243	51	57

DIVERS (loons, grebes, cormorants)

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	0	.	0	0
89/10/20	1	0	.	0	0
89/10/27	1	0	.	0	0
89/11/06	1	0	.	0	0
89/11/11	1	0	.	0	0
89/11/13	1	3	.	3	3
89/11/17	1	0	.	0	0
89/11/21	2	0	0	0	0
89/11/24	1	0	.	0	0
89/12/04	2	0	0	0	0
89/12/08	2	4	2.828	2	6
89/12/15	1	0	.	0	0
89/12/22	1	2	.	2	2
90/01/02	1	7	.	7	7
90/01/08	2	.5	.7071	0	1
90/01/12	2	0	0	0	0

TOTAL BIRDS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	2086	.	2086	2086
89/10/20	1	2680	.	2680	2680
89/10/27	1	2536	.	2536	2536
89/11/06	1	3407	.	3407	3407
89/11/11	1	3480	.	3480	3480
89/11/13	1	1208	.	1208	1208
89/11/17	1	1200	.	1200	1200
89/11/21	2	953	106.1	878	1028
89/11/24	1	549	.	549	549
89/12/04	2	606.5	177.5	481	732
89/12/08	2	1548	268	1358	1737
89/12/15	1	1019	.	1019	1019
89/12/22	1	575	.	575	575
90/01/02	1	649	.	649	649
90/01/08	2	389	172.5	267	511
90/01/12	2	1658	253.1	1479	1837

Daily mean numbers of birds recorded at Fraser R. middle arm south during 1989/90 aerial censuses.

DABBLERS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	300	.	300	300
89/10/20	1	0	.	0	0
89/10/27	1	150	.	150	150
89/11/06	1	0	.	0	0
89/11/11	1	0	.	0	0
89/11/13	1	0	.	0	0
89/11/17	1	0	.	0	0
89/11/21	1	0	.	0	0
89/11/24	1	150	.	150	150
89/12/04	1	0	.	0	0
89/12/08	1	0	.	0	0
89/12/15	1	0	.	0	0
89/12/22	1	0	.	0	0
90/01/02	1	350	.	350	350
90/01/12	2	50	70.71	0	100

DIVING DUCKS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	0	.	0	0
89/10/20	1	0	.	0	0
89/10/27	1	0	.	0	0
89/11/06	1	0	.	0	0
89/11/11	1	0	.	0	0
89/11/13	1	0	.	0	0
89/11/17	1	0	.	0	0
89/11/21	1	0	.	0	0
89/11/24	1	0	.	0	0
89/12/04	1	0	.	0	0
89/12/08	1	0	.	0	0
89/12/15	1	0	.	0	0
89/12/22	1	0	.	0	0
90/01/02	1	0	.	0	0
90/01/12	2	0	0	0	0

TOTAL DUCKS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	300	.	300	300
89/10/20	1	0	.	0	0
89/10/27	1	150	.	150	150
89/11/06	1	0	.	0	0
89/11/11	1	0	.	0	0
89/11/13	1	0	.	0	0
89/11/17	1	0	.	0	0
89/11/21	1	0	.	0	0
89/11/24	1	150	.	150	150
89/12/04	1	0	.	0	0
89/12/08	1	0	.	0	0
89/12/15	1	0	.	0	0
89/12/22	1	0	.	0	0
90/01/02	1	350	.	350	350
90/01/12	2	50	70.71	0	100

SNOW GEESE

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	0	.	0	0
89/10/20	1	0	.	0	0
89/10/27	1	30	.	30	30
89/11/06	1	0	.	0	0
89/11/11	1	0	.	0	0
89/11/13	1	0	.	0	0
89/11/17	1	0	.	0	0
89/11/21	1	0	.	0	0
89/11/24	1	0	.	0	0
89/12/04	1	0	.	0	0
89/12/08	1	0	.	0	0
89/12/15	1	0	.	0	0
89/12/22	1	0	.	0	0
90/01/02	1	0	.	0	0
90/01/12	2	0	0	0	0

TOTAL GEESE

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	0	.	0	0
89/10/20	1	0	.	0	0
89/10/27	1	30	.	30	30
89/11/06	1	0	.	0	0
89/11/11	1	0	.	0	0
89/11/13	1	0	.	0	0
89/11/17	1	0	.	0	0
89/11/21	1	0	.	0	0
89/11/24	1	0	.	0	0
89/12/04	1	0	.	0	0
89/12/08	1	0	.	0	0
89/12/15	1	0	.	0	0
89/12/22	1	0	.	0	0
90/01/02	1	0	.	0	0
90/01/12	2	0	0	0	0

SWANS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	0	.	0	0
89/10/20	1	0	.	0	0
89/10/27	1	0	.	0	0
89/11/06	1	0	.	0	0
89/11/11	1	0	.	0	0
89/11/13	1	0	.	0	0
89/11/17	1	0	.	0	0
89/11/21	1	0	.	0	0
89/11/24	1	0	.	0	0
89/12/04	1	0	.	0	0
89/12/08	1	0	.	0	0
89/12/15	1	0	.	0	0
89/12/22	1	0	.	0	0
90/01/02	1	0	.	0	0
90/01/12	2	0	0	0	0

WATERFOWL

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	300	.	300	300
89/10/20	1	0	.	0	0
89/10/27	1	180	.	180	180
89/11/06	1	0	.	0	0
89/11/11	1	0	.	0	0
89/11/13	1	0	.	0	0
89/11/17	1	0	.	0	0
89/11/21	1	0	.	0	0
89/11/24	1	150	.	150	150
89/12/04	1	0	.	0	0
89/12/08	1	0	.	0	0
89/12/15	1	0	.	0	0
89/12/22	1	0	.	0	0
90/01/02	1	350	.	350	350
90/01/12	2	50	70.71	0	100

SHOREBIRDS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	0	.	0	0
89/10/20	1	0	.	0	0
89/10/27	1	300	.	300	300
89/11/06	1	0	.	0	0
89/11/11	1	0	.	0	0
89/11/13	1	0	.	0	0
89/11/17	1	0	.	0	0
89/11/21	1	0	.	0	0
89/11/24	1	0	.	0	0
89/12/04	1	0	.	0	0
89/12/08	1	0	.	0	0
89/12/15	1	0	.	0	0
89/12/22	1	0	.	0	0
90/01/02	1	0	.	0	0
90/01/12	2	0	0	0	0

GULLS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	3	.	3	3
89/10/20	1	0	.	0	0
89/10/27	1	0	.	0	0
89/11/06	1	0	.	0	0
89/11/11	1	0	.	0	0
89/11/13	1	0	.	0	0
89/11/17	1	0	.	0	0
89/11/21	1	0	.	0	0
89/11/24	1	0	.	0	0
89/12/04	1	0	.	0	0
89/12/08	1	0	.	0	0
89/12/15	1	0	.	0	0
89/12/22	1	0	.	0	0
90/01/02	1	0	.	0	0
90/01/12	2	.5	.7071	0	1

DIVERS (loons, grebes, cormorants)

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	0	.	0	0
89/10/20	1	0	.	0	0
89/10/27	1	0	.	0	0
89/11/06	1	0	.	0	0
89/11/11	1	0	.	0	0
89/11/13	1	0	.	0	0
89/11/17	1	0	.	0	0
89/11/21	1	0	.	0	0
89/11/24	1	1	.	1	1
89/12/04	1	0	.	0	0
89/12/08	1	0	.	0	0
89/12/15	1	0	.	0	0
89/12/22	1	0	.	0	0
90/01/02	1	1	.	1	1
90/01/12	2	0	0	0	0

TOTAL BIRDS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	1	303	.	303	303
89/10/20	1	0	.	0	0
89/10/27	1	480	.	480	480
89/11/06	1	0	.	0	0
89/11/11	1	0	.	0	0
89/11/13	1	0	.	0	0
89/11/17	1	0	.	0	0
89/11/21	1	0	.	0	0
89/11/24	1	151	.	151	151
89/12/04	1	0	.	0	0
89/12/08	1	0	.	0	0
89/12/15	1	0	.	0	0
89/12/22	1	0	.	0	0
90/01/02	1	351	.	351	351
90/01/12	2	50.5	71.42	0	101

Daily mean numbers of birds recorded at Lulu Island during 1989/90 aerial censuses.

DABBLERS

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	1	1770	.	1770	1770
89/10/20	1	5800	.	5800	5800
89/10/27	3	8980	1900	7675	11160
89/11/06	2	4255	1591	3130	5380
89/11/11	1	860	.	860	860
89/11/13	3	601	106.1	530	723
89/11/17	1	499	.	499	499
89/11/21	2	1130	205.1	985	1275
89/11/24	1	2745	.	2745	2745
89/12/04	2	85	91.92	20	150
89/12/08	2	2110	841.5	1515	2705
89/12/15	3	1019	495.7	618	1573
89/12/22	1	635	.	635	635
90/01/02	3	1169	439.7	815	1661
90/01/08	3	1137	382.6	875	1576
90/01/12	3	559	285.5	230	742

DIVING DUCKS

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	1	50	.	50	50
89/10/20	1	0	.	0	0
89/10/27	3	0	0	0	0
89/11/06	2	0	0	0	0
89/11/11	1	250	.	250	250
89/11/13	3	3.333	5.774	0	10
89/11/17	1	400	.	400	400
89/11/21	2	202.5	279.3	5	400
89/11/24	1	75	.	75	75
89/12/04	2	32	45.25	0	64
89/12/08	2	70	42.43	40	100
89/12/15	3	10	17.32	0	30
89/12/22	1	50	.	50	50
90/01/02	3	279	193.1	102	485
90/01/08	3	1.333	2.309	0	4
90/01/12	3	183.3	118.1	90	275

TOTAL DUCKS

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	1	1820	.	1820	1820
89/10/20	1	5800	.	5800	5800
89/10/27	3	8980	1900	7675	11160
89/11/06	2	4255	1591	3130	5380
89/11/11	1	1110	.	1110	1110
89/11/13	3	604.3	111.9	530	733
89/11/17	1	899	.	899	899
89/11/21	2	1333	484.4	990	1675
89/11/24	1	2820	.	2820	2820
89/12/04	2	117	137.2	20	214
89/12/08	2	2180	799.0	1615	2745
89/12/15	3	1029	491.3	618	1573
89/12/22	1	685	.	685	685
90/01/02	3	1448	631.4	917	2146
90/01/08	3	1138	381.6	875	1576
90/01/12	3	742.3	216.8	505	930

SNOW GEESE

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	1	300	.	300	300
89/10/20	1	1650	.	1650	1650
89/10/27	3	2562	858.9	1660	3370
89/11/06	2	1320	311.1	1100	1540
89/11/11	1	1178	.	1178	1178
89/11/13	3	2067	929.2	1000	2700
89/11/17	1	2700	.	2700	2700
89/11/21	2	2150	1626	1000	3300
89/11/24	1	2830	.	2830	2830
89/12/04	2	3500	707.1	3000	4000
89/12/08	2	4763	4472	1600	7925
89/12/15	3	2380	998.5	1583	3500
89/12/22	1	2050	.	2050	2050
90/01/02	3	717.7	331.9	503	1100
90/01/08	3	350	350	0	700
90/01/12	3	0	0	0	0

TOTAL GEESE

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	1	300	.	300	300
89/10/20	1	1650	.	1650	1650
89/10/27	3	2562	858.9	1660	3370
89/11/06	2	1320	311.1	1100	1540
89/11/11	1	1178	.	1178	1178
89/11/13	3	2067	929.2	1000	2700
89/11/17	1	2700	.	2700	2700
89/11/21	2	2150	1626	1000	3300
89/11/24	1	2830	.	2830	2830
89/12/04	2	3500	707.1	3000	4000
89/12/08	2	4763	4472	1600	7925
89/12/15	3	2380	998.5	1583	3500
89/12/22	1	2050	.	2050	2050
90/01/02	3	717.7	331.9	503	1100
90/01/08	3	350	350	0	700
90/01/12	3	0	0	0	0

SWANS

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	1	0	.	0	0
89/10/20	1	0	.	0	0
89/10/27	3	4	3.464	0	6
89/11/06	2	5	0	5	5
89/11/11	1	5	.	5	5
89/11/13	3	22	0	22	22
89/11/17	1	4	.	4	4
89/11/21	2	10	14.14	0	20
89/11/24	1	35	.	35	35
89/12/04	2	34.5	3.536	32	37
89/12/08	2	16.5	12.02	8	25
89/12/15	3	19.67	34.06	0	59
89/12/22	1	5	.	5	5
90/01/02	3	16	4.583	12	21
90/01/08	3	96	68.79	44	174
90/01/12	3	39.67	26.58	9	56

WATERFOWL

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	1	2120	.	2120	2120
89/10/20	1	7450	.	7450	7450
89/10/27	3	11546	1249	10331	12826
89/11/06	2	5580	1280	4675	6485
89/11/11	1	2293	.	2293	2293
89/11/13	3	2693	1007	1552	3455
89/11/17	1	3603	.	3603	3603
89/11/21	2	3493	1128	2695	4290
89/11/24	1	5685	.	5685	5685
89/12/04	2	3652	847.9	3052	4251
89/12/08	2	6959	5284	3223	10695
89/12/15	3	3428	1140	2201	4454
89/12/22	1	2740	.	2740	2740
90/01/02	3	2181	668.6	1432	2717
90/01/08	3	1584	202.9	1358	1750
90/01/12	3	782	241.9	514	984

SHOREBIRDS

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	1	0	.	0	0
89/10/20	1	0	.	0	0
89/10/27	3	3.333	5.774	0	10
89/11/06	2	0	0	0	0
89/11/11	1	0	.	0	0
89/11/13	3	0	0	0	0
89/11/17	1	0	.	0	0
89/11/21	2	0	0	0	0
89/11/24	1	50	.	50	50
89/12/04	2	0	0	0	0
89/12/08	2	0	0	0	0
89/12/15	3	0	0	0	0
89/12/22	1	0	.	0	0
90/01/02	3	0	0	0	0
90/01/08	3	0	0	0	0
90/01/12	3	0	0	0	0

GULLS

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	1	2	.	2	2
89/10/20	1	8	.	8	8
89/10/27	3	371.7	635.1	3	1105
89/11/06	2	2.5	3.536	0	5
89/11/11	1	0	.	0	0
89/11/13	3	26.33	23.59	4	51
89/11/17	1	11	.	11	11
89/11/21	2	77	73.54	25	129
89/11/24	1	2	.	2	2
89/12/04	2	111.5	24.75	94	129
89/12/08	2	112	141.4	12	212
89/12/15	3	16.33	23.12	2	43
89/12/22	1	107	.	107	107
90/01/02	3	210.3	54.24	162	269
90/01/08	3	22.33	27.79	2	54
90/01/12	3	151	149.5	52	323

DIVERS (loons, grebes, cormorants)

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	1	0	.	0	0
89/10/20	1	0	.	0	0
89/10/27	3	.3333	.5774	0	1
89/11/06	2	0	0	0	0
89/11/11	1	2	.	2	2
89/11/13	3	3	3	0	6
89/11/17	1	0	.	0	0
89/11/21	2	.5	.7071	0	1
89/11/24	1	0	.	0	0
89/12/04	2	2.5	3.536	0	5
89/12/08	2	7.5	4.950	4	11
89/12/15	3	0	0	0	0
89/12/22	1	0	.	0	0
90/01/02	3	2.667	2.517	0	5
90/01/08	3	.3333	.5774	0	1
90/01/12	3	.6667	1.155	0	2

TOTAL BIRDS

Date	No. of Counts	Mean	Std. Dev	Minimum	Maximum
89/10/16	1	2122	.	2122	2122
89/10/20	1	7458	.	7458	7458
89/10/27	3	11922	1832	10346	13932
89/11/06	2	5583	1283	4675	6490
89/11/11	1	2295	.	2295	2295
89/11/13	3	2723	1020	1562	3479
89/11/17	1	3615	.	3615	3615
89/11/21	2	3570	1054	2825	4315
89/11/24	1	5737	.	5737	5737
89/12/04	2	3766	869	3151	4380
89/12/08	2	7079	5430	3239	10918
89/12/15	3	3445	1159	2203	4497
89/12/22	1	2848	.	2848	2848
90/01/02	3	2396	668.1	1635	2886
90/01/08	3	1607	174.7	1413	1752
90/01/12	3	933.7	115.2	839	1062

Daily mean numbers of birds recorded at Hasthan Island during 1989/90 aerial censuses.

DABBLERS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	1489	705.4	864	2254
89/10/20	3	565.3	229	321	775
89/10/27	3	4098	1585	2600	5758
89/11/06	3	616.7	125.8	500	750
89/11/11	3	174	167.3	25	355
89/11/13	3	571.7	454.9	128	1037
89/11/17	3	909	44.31	880	960
89/11/21	3	2473	733.3	1760	3225
89/11/24	3	1604	255.9	1322	1821
89/12/04	2	565	473.8	230	900
89/12/08	2	3340	579.8	2930	3750
89/12/15	3	2067	611.0	1400	2600
89/12/22	3	590	130.8	440	680
90/01/02	3	3435	872.4	2432	4018
90/01/08	3	1257	1047	50	1920
90/01/12	2	526	246.1	352	700

DIVING DUCKS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	3.333	5.774	0	10
89/10/20	3	.6667	1.155	0	2
89/10/27	3	0	0	0	0
89/11/06	3	66.67	115.5	0	200
89/11/11	3	60	52.96	0	100
89/11/13	3	.6667	1.155	0	2
89/11/17	3	27	16.64	15	46
89/11/21	3	6.667	11.55	0	20
89/11/24	3	218.3	378.2	0	655
89/12/04	2	25	35.36	0	50
89/12/08	2	25	35.36	0	50
89/12/15	3	0	0	0	0
89/12/22	3	4.333	5.859	0	11
90/01/02	3	118.3	200.6	0	350
90/01/08	3	258.3	231.3	55	510
90/01/12	2	13	18.38	0	26

TOTAL DUCKS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	1493	710.8	864	2264
89/10/20	3	566	227.9	323	775
89/10/27	3	4098	1585.	2600	5758
89/11/06	3	683.3	236.3	500	950
89/11/11	3	234	174.3	125	435
89/11/13	3	572.3	453.9	130	1037
89/11/17	3	936	42.58	895	980
89/11/21	3	2480	723.5	1780	3225
89/11/24	3	1823	501.5	1322	2325
89/12/04	2	590	509.1	230	950
89/12/08	2	3365	615.2	2930	3800
89/12/15	3	2067	611.0	1400	2600
89/12/22	3	594.3	132.3	442	680
90/01/02	3	3553	1004	2432	4368
90/01/08	3	1515	827.2	560	2010
90/01/12	2	539	227.7	378	700

SNOW GEESE

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	2182	551.4	1545	2500
89/10/20	3	1837	574.5	1500	2500
89/10/27	3	8907	2104	6817	11025
89/11/06	3	166.7	208.2	0	400
89/11/11	3	1300	173.2	1200	1500
89/11/13	3	2033	1050	1000	3100
89/11/17	3	2335	2084	0	4005
89/11/21	3	3317	901.9	2450	4250
89/11/24	3	2038	466.5	1730	2575
89/12/04	2	2300	424.3	2000	2600
89/12/08	2	4000	707.1	3500	4500
89/12/15	3	2833	1041	2000	4000
89/12/22	3	4217	1103	3000	5150
90/01/02	3	2348	548.8	1810	2907
90/01/08	3	0	0	0	0
90/01/12	2	0	0	0	0

TOTAL GEESE

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	2182	551.4	1545	2500
89/10/20	3	1837	574.5	1500	2500
89/10/27	3	8907	2104	6817	11025
89/11/06	3	166.7	208.2	0	400
89/11/11	3	1300	173.2	1200	1500
89/11/13	3	2033	1050	1000	3100
89/11/17	3	2335	2084	0	4005
89/11/21	3	3317	901.9	2450	4250
89/11/24	3	2038	466.5	1730	2575
89/12/04	2	2300	424.3	2000	2600
89/12/08	2	4000	707.1	3500	4500
89/12/15	3	2833	1041	2000	4000
89/12/22	3	4217	1103	3000	5150
90/01/02	3	2348	548.8	1810	2907
90/01/08	3	0	0	0	0
90/01/12	2	0	0	0	0

SWANS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	0	0	0	0
89/10/20	3	0	0	0	0
89/10/27	3	1.333	1.155	0	2
89/11/06	3	0	0	0	0
89/11/11	3	4.667	1.155	4	6
89/11/13	3	12.67	.5774	12	13
89/11/17	3	70.67	9.074	64	81
89/11/21	3	7.667	.5774	7	8
89/11/24	3	24	6.245	19	31
89/12/04	2	18	7.071	13	23
89/12/08	2	5.5	.7071	5	6
89/12/15	3	18	2	16	20
89/12/22	3	56	18.19	35	67
90/01/02	3	54	18.36	33	67
90/01/08	3	121	107.4	0	205
90/01/12	2	11	1.414	10	12

WATERFOWL

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	3674	269.5	3364	3850
89/10/20	3	2403	643.1	1833	3100
89/10/27	3	13006	3686.	9419	16785
89/11/06	3	850	217.9	600	1000
89/11/11	3	1539	179.9	1331	1646
89/11/13	3	2618	1358	1562	4150
89/11/17	3	3342	2046	1044	4967
89/11/21	3	5804	819.9	4893	6482
89/11/24	3	3885	218.2	3653	4086
89/12/04	2	2908	940.5	2243	3573
89/12/08	2	7371	91.22	7306	7435
89/12/15	3	4918	1409	3420	6216
89/12/22	3	4867	1035	3696	5658
90/01/02	3	5956	718.4	5372	6758
90/01/08	3	1636	932.7	560	2215
90/01/12	2	550	226.3	390	710

SHOREBIRDS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	0	0	0	0
89/10/20	3	0	0	0	0
89/10/27	3	133.3	57.74	100	200
89/11/06	3	0	0	0	0
89/11/11	3	0	0	0	0
89/11/13	3	16.67	28.87	0	50
89/11/17	3	0	0	0	0
89/11/21	3	0	0	0	0
89/11/24	3	0	0	0	0
89/12/04	2	0	0	0	0
89/12/08	2	7.5	10.61	0	15
89/12/15	3	25	43.30	0	75
89/12/22	3	0	0	0	0
90/01/02	3	0	0	0	0
90/01/08	3	0	0	0	0
90/01/12	2	0	0	0	0

GULLS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	65.67	109.4	0	192
89/10/20	3	7.667	6.807	0	13
89/10/27	3	64.33	43.39	18	104
89/11/06	3	20.67	27.59	0	52
89/11/11	3	1.667	2.082	0	4
89/11/13	3	7.333	4.933	4	13
89/11/17	3	212.3	260.8	15	508
89/11/21	3	92	142.9	6	257
89/11/24	3	36	50.27	5	94
89/12/04	2	213.5	140.7	114	313
89/12/08	2	101	32.53	78	124
89/12/15	3	208.7	179	2	317
89/12/22	3	243.7	181.7	35	367
90/01/02	3	156.3	58.65	120	224
90/01/08	3	41	32.92	21	79
90/01/12	2	206	186.7	74	338

DIVERS (loons, grebes, cormorants)

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	0	0	0	0
89/10/20	3	.3333	.5774	0	1
89/10/27	3	1	1.732	0	3
89/11/06	3	.3333	.5774	0	1
89/11/11	3	1.667	1.528	0	3
89/11/13	3	.3333	.5774	0	1
89/11/17	3	4	2.646	2	7
89/11/21	3	5	5	0	10
89/11/24	3	3.333	2.082	1	5
89/12/04	2	0	0	0	0
89/12/08	2	3.5	.7071	3	4
89/12/15	3	0	0	0	0
89/12/22	3	.3333	.5774	0	1
90/01/02	3	1	1	0	2
90/01/08	3	.6667	1.155	0	2
90/01/12	2	2.5	.7071	2	3

TOTAL BIRDS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	3740	330.0	3369	4001
89/10/20	3	2411	642.3	1847	3110
89/10/27	3	13206	3643	9623	16907
89/11/06	3	871.3	191.4	653	1010
89/11/11	3	1542	181.4	1333	1654
89/11/13	3	2643	1385	1566	4205
89/11/17	3	3558	2181	1061	5088
89/11/21	3	5903	926.4	4911	6746
89/11/24	3	3924	174.5	3751	4100
89/12/04	2	3122	799.7	2556	3687
89/12/08	2	7483	68.59	7434	7531
89/12/15	3	5152	1610	3422	6608
89/12/22	3	5112	1217	3731	6027
90/01/02	3	6114	681.3	5598	6886
90/01/08	3	1678	948.4	583	2236
90/01/12	2	759	38.18	732	786

Daily mean numbers of birds observed at Brunswick Point during 1989/90 aerial censuses.

DABBLERS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	2933	2485	1050	5750
89/10/20	3	2655	803.8	1940	3525
89/10/27	3	736.7	772.7	110	1600
89/11/06	3	1050	507.5	500	1500
89/11/11	3	70	112.7	0	200
89/11/13	3	50	50	0	100
89/11/17	3	356.3	70.50	280	419
89/11/21	3	1473	219.4	1300	1720
89/11/24	3	583.3	103	505	700
89/12/04	2	162.5	53.03	125	200
89/12/08	2	752.5	562.1	355	1150
89/12/15	3	1673	127.0	1600	1820
89/12/22	3	487.3	208.7	252	650
90/01/02	3	1058	339.4	700	1375
90/01/08	3	236.7	251.1	0	500
90/01/12	3	85	60.62	50	155

DIVING DUCKS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	0	0	0	0
89/10/20	3	0	0	0	0
89/10/27	3	39	67.55	0	117
89/11/06	3	166.7	208.2	0	400
89/11/11	3	50	50	0	100
89/11/13	3	0	0	0	0
89/11/17	3	2.333	4.041	0	7
89/11/21	3	116.7	202.1	0	350
89/11/24	3	10	17.32	0	30
89/12/04	2	0	0	0	0
89/12/08	2	58	60.81	15	101
89/12/15	3	66.67	115.5	0	200
89/12/22	3	0	0	0	0
90/01/02	3	38.33	33.29	0	60
90/01/08	3	0	0	0	0
90/01/12	3	1.667	2.887	0	5

TOTAL DUCKS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	2933	2485	1050	5750
89/10/20	3	2655	803.8	1940	3525
89/10/27	3	775.7	838.2	110	1717
89/11/06	3	1217	700.6	500	1900
89/11/11	3	120	72.11	60	200
89/11/13	3	50	50	0	100
89/11/17	3	358.7	73.66	280	426
89/11/21	3	1590	168.2	1400	1720
89/11/24	3	593.3	120	505	730
89/12/04	2	162.5	53.03	125	200
89/12/08	2	810.5	501.3	456	1165
89/12/15	3	1740	242.5	1600	2020
89/12/22	3	487.3	208.7	252	650
90/01/02	3	1097	314.8	755	1375
90/01/08	3	236.7	251.1	0	500
90/01/12	3	86.67	59.23	50	155

SNOW GEESE

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	0	0	0	0
89/10/20	3	3000	4359	0	8000
89/10/27	3	1337	282.9	1010	1500
89/11/06	3	0	0	0	0
89/11/11	3	6.667	11.55	0	20
89/11/13	3	0	0	0	0
89/11/17	3	0	0	0	0
89/11/21	3	933.3	339.4	575	1250
89/11/24	3	736.7	1267	0	2200
89/12/04	2	0	0	0	0
89/12/08	2	105	148.5	0	210
89/12/15	3	0	0	0	0
89/12/22	3	2000	500	1500	2500
90/01/02	3	4.667	6.429	0	12
90/01/08	3	0	0	0	0
90/01/12	3	0	0	0	0

TOTAL GEESE

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	0	0	0	0
89/10/20	3	3000	4359	0	8000
89/10/27	3	1337	282.9	1010	1500
89/11/06	3	0	0	0	0
89/11/11	3	6.667	11.55	0	20
89/11/13	3	0	0	0	0
89/11/17	3	0	0	0	0
89/11/21	3	933.3	339.4	575	1250
89/11/24	3	736.7	1267	0	2200
89/12/04	2	0	0	0	0
89/12/08	2	105	148.5	0	210
89/12/15	3	0	0	0	0
89/12/22	3	2000	500	1500	2500
90/01/02	3	4.667	6.429	0	12
90/01/08	3	0	0	0	0
90/01/12	3	0	0	0	0

SWANS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	0	0	0	0
89/10/20	3	0	0	0	0
89/10/27	3	0	0	0	0
89/11/06	3	0	0	0	0
89/11/11	3	4.667	8.083	0	14
89/11/13	3	0	0	0	0
89/11/17	3	18.33	10.26	7	27
89/11/21	3	12.67	10.97	0	19
89/11/24	3	8.333	2.887	5	10
89/12/04	2	16	2.828	14	18
89/12/08	2	9	9.899	2	16
89/12/15	3	23.67	6.658	18	31
89/12/22	3	49.33	13.32	34	58
90/01/02	3	83.67	10.41	72	92
90/01/08	3	17.33	1.155	16	18
90/01/12	3	8.667	3.055	6	12

WATERFOWL

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	2933	2485	1050	5750
89/10/20	3	5655	4390	1940	10500
89/10/27	3	2112	566.9	1610	2727
89/11/06	3	1217	700.6	500	1900
89/11/11	3	131.3	77.62	60	214
89/11/13	3	50	50	0	100
89/11/17	3	377	83.88	287	453
89/11/21	3	2536	397.7	2244	2989
89/11/24	3	1338	1232	520	2755
89/12/04	2	178.5	50.2	143	214
89/12/08	2	924.5	639.9	472	1377
89/12/15	3	1764	237.6	1622	2038
89/12/22	3	2537	585.7	2118	3206
90/01/02	3	1185	309.2	844	1447
90/01/08	3	254	252	16	518
90/01/12	3	95.33	58.60	61	163

SHOREBIRDS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	0	0	0	0
89/10/20	3	0	0	0	0
89/10/27	3	616.7	900.5	0	1650
89/11/06	3	0	0	0	0
89/11/11	3	8667	8083	0	16000
89/11/13	3	10517	8402	4000	20000
89/11/17	3	166.7	288.7	0	500
89/11/21	3	136.7	228.1	0	400
89/11/24	3	66.67	115.5	0	200
89/12/04	2	150	212.1	0	300
89/12/08	2	0	0	0	0
89/12/15	3	6767	5862	0	10300
89/12/22	3	6667	5774	0	10000
90/01/02	3	166.7	288.7	0	500
90/01/08	3	0	0	0	0
90/01/12	3	1667	2887	0	5000

GULLS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	22	9.849	11	30
89/10/20	3	34.67	36.07	0	72
89/10/27	3	196	36.1	155	223
89/11/06	3	2	1	1	3
89/11/11	3	.3333	.5774	0	1
89/11/13	3	7.333	6.807	2	15
89/11/17	3	75.33	82.08	24	170
89/11/21	3	4	2.646	2	7
89/11/24	3	6	5.568	0	11
89/12/04	2	50.5	47.38	17	84
89/12/08	2	.5	.7071	0	1
89/12/15	3	168.3	101.3	55	250
89/12/22	3	63.33	28.87	30	80
90/01/02	3	78	22.91	53	98
90/01/08	3	4.333	3.215	2	8
90/01/12	3	97	30.79	63	123

DIVERS (loons, grebes, cormorants)

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	0	0	0	0
89/10/20	3	.3333	.5774	0	1
89/10/27	3	0	0	0	0
89/11/06	3	0	0	0	0
89/11/11	3	2.333	2.517	0	5
89/11/13	3	0	0	0	0
89/11/17	3	.6667	1.155	0	2
89/11/21	3	1	1	0	2
89/11/24	3	0	0	0	0
89/12/04	2	0	0	0	0
89/12/08	2	1	1.414	0	2
89/12/15	3	.6667	1.155	0	2
89/12/22	3	0	0	0	0
90/01/02	3	0	0	0	0
90/01/08	3	.3333	.5774	0	1
90/01/12	3	.3333	.5774	0	1

TOTAL BIRDS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	2956	2493	1062	5780
89/10/20	3	5690	4417	1972	10572
89/10/27	3	2926	1011	1821	3805
89/11/06	3	1219	701.6	501	1903
89/11/11	3	8801	8007	214	16062
89/11/13	3	10574	8446	4055	20115
89/11/17	3	620.7	339.5	315	986
89/11/21	3	2678	312.7	2378	3002
89/11/24	3	1411	1174	720	2766
89/12/04	2	379	215	227	531
89/12/08	2	926	640.6	473	1379
89/12/15	3	8699	5910	1883	12393
89/12/22	3	9267	5223	3236	12366
90/01/02	3	1430	456	943	1847
90/01/08	3	258.7	251.2	19	520
90/01/12	3	1859	2865	126	5166

Daily mean numbers of birds recorded at Roberts Bank during 1989/90 aerial censuses.

DABBLERS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	9353	327.2	9050	9700
89/10/20	3	13217	5666	7200	18450
89/10/27	3	10300	6745	3000	16300
89/11/06	3	12577	1308	11080	13500
89/11/11	3	16592	3343	12775	19000
89/11/13	3	8911	1424	7333	10100
89/11/17	3	7876	2187	5858	10200
89/11/21	3	8958	773.8	8310	9815
89/11/24	3	7148	1135	6095	8350
89/12/04	2	3705	275.8	3510	3900
89/12/08	2	9280	926.3	8625	9935
89/12/15	3	7217	880.8	6200	7750
89/12/22	3	7312	2565	5300	10200
90/01/02	3	6533	1518	4900	7900
90/01/08	3	9508	1051	8350	10400
90/01/12	3	7417	548.5	6800	7850

DIVING DUCKS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	33.33	57.74	0	100
89/10/20	3	0	0	0	0
89/10/27	3	683.3	592.3	0	1050
89/11/06	3	550	909.7	0	1600
89/11/11	3	473.3	352.3	100	800
89/11/13	3	34	58.89	0	102
89/11/17	3	20.33	30.17	0	55
89/11/21	3	245	160.2	150	430
89/11/24	3	95	82.61	0	150
89/12/04	2	37.5	53.03	0	75
89/12/08	2	421	369.1	160	682
89/12/15	3	0	0	0	0
89/12/22	3	0	0	0	0
90/01/02	3	0	0	0	0
90/01/08	3	26.67	25.17	0	50
90/01/12	3	16.67	28.87	0	50

TOTAL DUCKS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	9387	380.8	9050	9800
89/10/20	3	13217	5666	7200	18450
89/10/27	3	10983	6317	4000	16300
89/11/06	3	13127	1985	11130	15100
89/11/11	3	17065	3646	12875	19520
89/11/13	3	8945	1439	7333	10100
89/11/17	3	7897	2187	5858	10206
89/11/21	3	9203	664.8	8740	9965
89/11/24	3	7243	1057	6245	8350
89/12/04	2	3743	222.7	3585	3900
89/12/08	2	9701	1295	8785	10617
89/12/15	3	7217	880.8	6200	7750
89/12/22	3	7312	2565	5300	10200
90/01/02	3	6533	1518	4900	7900
90/01/08	3	9535	104.	8380	10400
90/01/12	3	7433	557.5	6800	7850

SNOW GEESE

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	0	0	0	0
89/10/20	3	0	0	0	0
89/10/27	3	0	0	0	0
89/11/06	3	0	0	0	0
89/11/11	3	0	0	0	0
89/11/13	3	0	0	0	0
89/11/17	3	0	0	0	0
89/11/21	3	0	0	0	0
89/11/24	3	.3333	.5774	0	1
89/12/04	2	0	0	0	0
89/12/08	2	0	0	0	0
89/12/15	3	0	0	0	0
89/12/22	3	.3333	.5773	0	1
90/01/02	3	0	0	0	0
90/01/08	3	0	0	0	0
90/01/12	3	0	0	0	0

TOTAL GEESE

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	102	171.5	0	300
89/10/20	3	0	0	0	0
89/10/27	3	0	0	0	0
89/11/06	3	0	0	0	0
89/11/11	3	0	0	0	0
89/11/13	3	0	0	0	0
89/11/17	3	0	0	0	0
89/11/21	3	0	0	0	0
89/11/24	3	.3333	.5774	0	1
89/12/04	2	0	0	0	0
89/12/08	2	0	0	0	0
89/12/15	3	16.67	28.87	0	50
89/12/22	3	.3333	.5774	0	1
90/01/02	3	0	0	0	0
90/01/08	3	0	0	0	0
90/01/12	3	0	0	0	0

SWANS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	0	0	0	0
89/10/20	3	0	0	0	0
89/10/27	3	0	0	0	0
89/11/06	3	0	0	0	0
89/11/11	3	7	6.083	0	11
89/11/13	3	.3333	.5774	0	1
89/11/17	3	1	1.732	0	3
89/11/21	3	0	0	0	0
89/11/24	3	0	0	0	0
89/12/04	2	0	0	0	0
89/12/08	2	0	0	0	0
89/12/15	3	.3333	.5774	0	1
89/12/22	3	0	0	0	0
90/01/02	3	0	0	0	0
90/01/08	3	.6667	1.155	0	2
90/01/12	3	0	0	0	0

WATERFOWL

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	9489	545.9	9050	10100
89/10/20	3	13217	5666	7200	18450
89/10/27	3	10983	6317	4000	16300
89/11/06	3	13127	1985	11130	15100
89/11/11	3	17072	3643	12886	19520
89/11/13	3	8945	1438	7334	10100
89/11/17	3	7898	2185	5861	10206
89/11/21	3	9203	664.8	8740	9965
89/11/24	3	7244	1057	6245	8350
89/12/04	2	3743	222.7	3585	3900
89/12/08	2	9701	1295	8785	10617
89/12/15	3	7234	894.3	6201	7750
89/12/22	3	7312	2565	5301	10200
90/01/02	3	6533	1518	4900	7900
90/01/08	3	9536	1040	8382	10400
90/01/12	3	7433	557.5	6800	7850

SHOREBIRDS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	193.3	265.8	30	500
89/10/20	3	0	0	0	0
89/10/27	3	33.33	57.74	0	100
89/11/06	3	100	173.2	0	300
89/11/11	3	233.3	251.7	0	500
89/11/13	3	50	50	0	100
89/11/17	3	566.7	450.9	100	1000
89/11/21	3	66.67	115.5	0	200
89/11/24	3	0	0	0	0
89/12/04	2	0	0	0	0
89/12/08	2	0	0	0	0
89/12/15	3	5700	5511	0	11000
89/12/22	3	333.3	577.4	0	1000
90/01/02	3	4000	1732	2000	5000
90/01/08	3	0	0	0	0
90/01/12	3	1667	2887	0	5000

GULLS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	174.3	202.9	34	407
89/10/20	3	129	70.68	49	183
89/10/27	3	61	55.51	6	117
89/11/06	3	2	3.464	0	6
89/11/11	3	16	15.59	7	34
89/11/13	3	34	25.87	6	57
89/11/17	3	32	24.27	5	52
89/11/21	3	23.67	3.215	20	26
89/11/24	3	7.667	1.528	6	9
89/12/04	2	13	9.899	6	20
89/12/08	2	9.5	4.95	6	13
89/12/15	3	224.7	118.1	133	358
89/12/22	3	41.67	59.23	5	110
90/01/02	3	258.3	75.16	175	321
90/01/08	3	29	12.53	17	42
90/01/12	3	47	28.83	21	78

DIVERS (loons, grebes, cormorants)

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	0	0	0	0
89/10/20	3	0	0	0	0
89/10/27	3	0	0	0	0
89/11/06	3	0	0	0	0
89/11/11	3	7	8.185	0	16
89/11/13	3	6	8.660	1	16
89/11/17	3	0	0	0	0
89/11/21	3	1.667	2.082	0	4
89/11/24	3	1.333	1.528	0	3
89/12/04	2	0	0	0	0
89/12/08	2	3.5	.7071	3	4
89/12/15	3	0	0	0	0
89/12/22	3	0	0	0	0
90/01/02	3	3	2.646	0	5
90/01/08	3	.6667	1.155	0	2
90/01/12	3	.6667	.5774	0	1

TOTAL BIRDS

Date	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
89/10/16	3	9856	336.1	9584	10232
89/10/20	3	13346	5644	7383	18605
89/10/27	3	11078	6279	4160	16417
89/11/06	3	13229	2136	11130	15400
89/11/11	3	17335	3832	12916	19744
89/11/13	3	9035	1429	7457	10240
89/11/17	3	8500	2463	6513	11255
89/11/21	3	9296	630.2	8764	9992
89/11/24	3	7254	1056	6254	8359
89/12/04	2	3756	212.8	3605	3906
89/12/08	2	9714	1291	8801	10627
89/12/15	3	13158	6228	6559	18933
89/12/22	3	7687	2185	6412	10210
90/01/02	3	10795	3149	7226	13183
90/01/08	3	9565	1047	8401	10428
90/01/12	3	9148	3094	6878	12672

APPENDIX 2

Monthly summaries of numbers of birds seen by species groups, on each transect, for each survey.

Monthly mean number of birds recorded at Boundary Bay during 1989/90 aerial censuses. Calculated from daily mean numbers.

DABBLERS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	20045	4187	17198	24853
Nov/89	6	24744	4689	19733	33202
Dec/89	4	33633	7625	24272	39994
Jan/90	3	23858	1557	22746	25637

DIVING DUCKS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	1253	1916	0	3459
Nov/89	6	1678	1285	658.6	3850
Dec/89	4	453.9	472.6	2	1056
Jan/90	3	748.4	422.5	385	1212

TOTAL DUCKS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	21298	6081	17498	28312
Nov/89	6	26422	5496	22219	37052
Dec/89	4	34088	7733	24866	41051
Jan/90	3	24606	1944	23394	26848

SNOW GEESE

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	0	0	0	0
Nov/89	6	0	0	0	0
Dec/89	4	0	0	0	0
Jan/90	3	0	0	0	0

TOTAL GEESE

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	0	0	0	0
Nov/89	6	0	0	0	0
Dec/89	4	0	0	0	0
Jan/90	3	11.11	16.44	0	30

SWANS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	3.89	6.738	0	11.67
Nov/89	6	6.277	8.904	0	21.67
Dec/89	4	.1675	.335	0	.67
Jan/90	3	0	0	0	0

WATERFOWL

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	21302	6088	17498	28324
Nov/89	6	26428	5502	22231	37073
Dec/89	4	34088	7733	24866	41051
Jan/90	3	24617	1935	23398	26848

SHOREBIRDS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	5507	7534	366.6	14155
Nov/89	6	4965	4669	33.3	12000
Dec/89	4	14640	6885	5200	19787
Jan/90	3	2367	1550	818	3917

GULLS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	1332	724.9	520	1914
Nov/89	6	869.5	1125	51	2440
Dec/89	4	2309	1549	528	4229
Jan/90	3	1957	1400	606.3	3402

DIVERS (loons, grebes, cormorants)

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	.11	.1905	0	.33
Nov/89	6	4	7.71	0	19.67
Dec/89	4	29.59	25.32	6	63.67
Jan/90	3	8.777	4.525	4	13

TOTAL BIRDS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	28151	13784	19788	44060
Nov/89	6	32318	6429	25192	43018
Dec/89	4	51068	13479	37600	63905
Jan/90	3	28952	3917	24836	32633

Monthly mean number of birds recorded on the Fraser River Foreshore (all transects combined during 1989/90) aerial censuses. Calculated from daily mean numbers.

DABBLERS

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	22316	4291	17380	25155
Nov/89	6	14525	3758	10733	18976
Dec/89	4	11078	5089	4883	16871
Jan/90	3	11669	1812	9601	12977

DIVING DUCKS

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	337.9	365.5	.67	726.3
Nov/89	6	595.5	266	338	1033
Dec/89	4	289.8	312.3	54.33	729.5
Jan/90	3	349.5	88.11	277.1	447.6

TOTAL DUCKS

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	22654	4380	17668	25881
Nov/89	6	15121	4005	11117	20009
Dec/89	4	11368	5257	5178	17600
Jan/90	3	12018	1884	9878	13425

SNOW GEESE

Month	No. of Counts	Mean	Std. Deviation	Minimum	Maximum
Oct/89	3	8068	5902	2782	14436
Nov/89	6	4894	1024	3485	6400
Dec/89	4	7045	1790	5243	8868
Jan/90	3	1140	1681	0	3070

TOTAL GEESE

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	8102	5856	2884	14436
Nov/89	6	4894	1024	3485	6400
Dec/89	4	7049	1784	5260	8868
Jan/90	3	1209	1685	75	3145

SWANS

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	1.777	3.077	0	5.33
Nov/89	6	42.17	32.64	5	94
Dec/89	4	67.87	32.65	31	110.3
Jan/90	3	149.3	87.91	59.34	235

WATERFOWL

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	30757	9901	20551	40321
Nov/89	6	20057	3711	15501	24174
Dec/89	4	18484	6319	11047	26499
Jan/90	3	13377	3356	10012	16724

SHOREBIRDS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	443.4	570.5	0	1087
Nov/89	6	3623	5139	100	10584
Dec/89	4	4912	6015	7.5	12492
Jan/90	3	2667	2316	0	4167

GULLS

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	395.4	296.9	184.3	734.9
Nov/89	6	120.9	122.7	18	334.6
Dec/89	4	431.7	161.9	223.5	617.8
Jan/90	3	493.8	365.8	101.1	824.9

DIVERS (loons, grebes, cormorants)

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	.6633	.6650	0	1.33
Nov/89	6	7.36	4.831	.33	13
Dec/89	4	6.25	8.872	.67	19.5
Jan/90	3	7.113	6.597	2.5	14.67

TOTAL BIRDS

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	31599	10543	21063	42148
Nov/89	6	23811	5721	17494	33453
Dec/89	4	23836	8535	11630	31473
Jan/90	3	16547	4516	13498	21735

Monthly mean number of birds recorded at Sea Island during 1989/90 aerial censuses. Calculated from daily mean numbers.

DABBLERS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	1533	642.5	890	2175
Nov/89	6	819.1	342.4	400	1280
Dec/89	4	827.3	454.1	365	1388
Jan/90	3	562	355.3	290	964

DIVING DUCKS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	68	114.3	0	200
Nov/89	6	83.33	132.9	0	300
Dec/89	4	89.88	103.1	0	200
Jan/90	3	37.33	25.25	12	62.5

TOTAL DUCKS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	1601	650.9	894	2175
Nov/89	6	902.4	388.4	400	1480
Dec/89	4	917	462.1	565	1543
Jan/90	3	599.5	374.8	327.5	1027

SNOW GEESE

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	800	700	300	1600
Nov/89	6	708.8	1187	0	3000
Dec/89	4	7.5	15	0	30
Jan/90	3	0	0	0	0

TOTAL GEESE

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	800	700	300	1600
Nov/89	6	708.8	1187	0	3000
Dec/89	4	7.5	15	0	30
Jan/90	3	68.83	10.68	56.5	75

SWANS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	0	0	0	0
Nov/89	6	0	0	0	0
Dec/89	4	0	0	0	0
Jan/90	3	0	0	0	0

WATERFOWL

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	2401	329.9	2035	2675
Nov/89	6	1611	1092	545	3400
Dec/89	4	924.5	463.9	565	1543
Jan/90	3	668.3	381.6	384	1102

SHOREBIRDS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	16.67	28.87	0	50
Nov/89	6	183.3	402.1	0	1000
Dec/89	4	0	0	0	0
Jan/90	3	166.7	288.7	0	500

GULLS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	15.67	22.94	0	42
Nov/89	6	4.417	3.639	0	10
Dec/89	4	10.5	19.35	0	39.5
Jan/90	3	60.17	58.99	4.5	122

DIVERS (loons, grebes, cormorants)

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	0	0	0	0
Nov/89	6	.5	1.225	0	3
Dec/89	4	1.5	1.915	0	4
Jan/90	3	2.5	3.905	0	7

TOTAL BIRDS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	2434	309.9	2086	2680
Nov/89	6	1800	1296	549	3480
Dec/89	4	937.1	454.7	575	1548
Jan/90	3	898.7	670.3	389	1658

Monthly mean number of birds recorded at the Fraser R. middle arm south during 1989/90 aerial censuses. Calculated from daily mean numbers.

DABBLERS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	150	150	0	300
Nov/89	6	25	61.24	0	150
Dec/89	4	0	0	0	0
Jan/90	3	133.3	189.3	0	350

DIVING DUCKS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	0	0	0	0
Nov/89	6	0	0	0	0
Dec/89	4	0	0	0	0
Jan/90	3	0	0	0	0

TOTAL DUCKS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	150	150	0	300
Nov/89	6	25	61.24	0	150
Dec/89	4	0	0	0	0
Jan/90	3	133.3	189.3	0	350

SNOW GEESE

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	10	17.32	0	30
Nov/89	6	0	0	0	0
Dec/89	4	0	0	0	0
Jan/90	3	0	0	0	0

TOTAL GEESE

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	10	17.32	0	30
Nov/89	6	0	0	0	0
Dec/89	4	0	0	0	0
Jan/90	3	0	0	0	0

SWANS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	0	0	0	0
Nov/89	6	0	0	0	0
Dec/89	4	0	0	0	0
Jan/90	3	0	0	0	0

WATERFOWL

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	160	151	0	300
Nov/89	6	25	61.24	0	150
Dec/89	4	0	0	0	0
Jan/90	3	133.3	189.3	0	350

SHOREBIRDS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	100	173.2	0	300
Nov/89	6	0	0	0	0
Dec/89	4	0	0	0	0
Jan/90	3	0	0	0	0

GULLS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	1	1.732	0	3
Nov/89	6	0	0	0	0
Dec/89	4	0	0	0	0
Jan/90	3	.1667	.2887	0	.5

DIVERS (loons, grebes, cormorants)

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	0	0	0	0
Nov/89	6	.1667	.4082	0	1
Dec/89	4	0	0	0	0
Jan/90	3	.3333	.5774	0	1

TOTAL BIRDS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	261	242.7	0	480
Nov/89	6	25.17	61.65	0	151
Dec/89	4	0	0	0	0
Jan/90	3	133.8	189.8	0	351

Monthly mean number of birds recorded at Lulu Island during 1989/90 aerial censuses. Calculated from daily mean numbers.

DABBLERS

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	5517	3613	1770	8980
Nov/89	6	1682	1503	499	4255
Dec/89	4	962.3	855.8	85	2110
Jan/90	3	955	343.3	559	1169

DIVING DUCKS

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	16.67	28.87	0	50
Nov/89	6	155.1	157.9	0	400
Dec/89	4	40.5	25.58	10	70
Jan/90	3	154.5	141.1	1.33	279

TOTAL DUCKS

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	5533	3587	1820	8980
Nov/89	6	1837	1414	604.3	4255
Dec/89	4	1003	870.3	117	2180
Jan/90	3	1109	353.7	742.3	1448

SNOW GEESE

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	1504	1138	300	2562
Nov/89	6	2041	683.2	1178	2830
Dec/89	4	3173	1228	2050	4763
Jan/90	3	355.9	358.8	0	717.6

TOTAL GEESE

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	1504	1138	300	2562
Nov/89	6	2041	683.2	1178	2830
Dec/89	4	3173	1228	2050	4763
Jan/90	3	355.9	358.8	0	717.6

SWANS

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	1.333	2.309	0	4
Nov/89	6	13.5	12.5	4	35
Dec/89	4	18.92	12.13	5	34.5
Jan/90	3	50.56	41.1	16	96

WATERFOWL

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	7039	4726	2120	11546
Nov/89	6	3891	1435	2293	5685
Dec/89	4	4195	1883	2740	6959
Jan/90	3	1516	702	782	2181

SHOREBIRDS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	1.11	1.923	0	3.33
Nov/89	6	8.333	20.41	0	50
Dec/89	4	1.875	3.75	0	7.5
Jan/90	3	0	0	0	0

GULLS

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	127.2	211.7	2	371.6
Nov/89	6	19.81	29.67	0	77
Dec/89	4	86.71	46.97	16.33	112
Jan/90	3	127.9	96.09	22.33	210.3

DIVERS (loons, grebes, cormorants)

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	.11	.1905	0	.33
Nov/89	6	.9167	1.281	0	3
Dec/89	4	2.5	3.536	0	7.5
Jan/90	3	1.223	1.264	.33	2.67

TOTAL BIRDS

Month	No. of Counts	Mean	Std. Dev	Minimum	Maximum
Oct/89	3	7167	4906	2122	11922
Nov/89	6	3921	1439	2295	5737
Dec/89	4	4285	1901	2848	7079
Jan/90	3	1646	732	933.6	2395

Monthly mean number of birds recorded at Westham Island during 1989/90 aerial censuses. Calculated from daily mean numbers.

DABBLERS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	2051	1832	565.3	4098
Nov/89	6	1058	840.9	174	2473
Dec/89	4	1641	1333	565	3340
Jan/90	3	1739	1513	526	3435

DIVING DUCKS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	1.333	1.761	0	3.33
Nov/89	6	63.22	80.62	.67	218.3
Dec/89	4	13.58	13.30	0	25
Jan/90	3	129.9	123.1	13	258.3

TOTAL DUCKS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	2052	1831	566	4098
Nov/89	6	1121	854.8	234	2480
Dec/89	4	1654	1336	590	3365
Jan/90	3	1869	1538	539	3553

SNOW GEESE

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	4309	3986	1837	8907
Nov/89	6	1865	1057	166.6	3317
Dec/89	4	3338	920.8	2300	4217
Jan/90	3	782.7	1356	0	2348

TOTAL GEESE

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	4309	3986	1837	8907
Nov/89	6	1865	1057	166.6	3317
Dec/89	4	3338	920.8	2300	4217
Jan/90	3	782.7	1356	0	2348

SWANS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	.4433	.7679	0	1.33
Nov/89	6	19.95	26.17	0	70.67
Dec/89	4	24.38	21.89	5.5	56
Jan/90	3	62	55.43	11	121

WATERFOWL

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	6361	5790	2403	13006
Nov/89	6	3006	1770	850	5804
Dec/89	4	5016	1828	2908	7371
Jan/90	3	2714	2860	550	5956

SHOREBIRDS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	44.43	76.96	0	133.3
Nov/89	6	2.778	6.805	0	16.67
Dec/89	4	6.25	12.5	0	25
Jan/90	3	0	0	0	0

GULLS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	45.89	33.11	7.67	65.67
Nov/89	6	61.66	80.63	1.67	212.3
Dec/89	4	191.7	62.4	101	243.6
Jan/90	3	134.4	84.65	41	206

DIVERS (loons, grebes, cormorants)

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	.4433	.5095	0	1
Nov/89	6	2.443	1.963	.33	5
Dec/89	4	.9575	1.702	0	3.5
Jan/90	3	1.39	.9753	.67	2.5

TOTAL BIRDS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	6452	5886	2411	13206
Nov/89	6	3074	1808	871.3	5903
Dec/89	4	5217	1783	3122	7483
Jan/90	3	2850	2864	759	6114

Monthly mean number of birds recorded at Brunswick Point during 1989/90 aerial censuses. Calculated from daily mean numbers.

DABBLERS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	2108	1196	736.6	2933
Nov/89	6	597.1	567	50	1473
Dec/89	4	768.8	649.3	162.5	1673
Jan/90	3	459.9	523.5	85	1058

DIVING DUCKS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	13	22.52	0	39
Nov/89	6	57.59	69.37	0	166.6
Dec/89	4	31.17	36.16	0	66.67
Jan/90	3	13.33	21.66	0	38.33

TOTAL DUCKS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	2121	1174	775.6	2933
Nov/89	6	654.8	621.9	50	1590
Dec/89	4	800.1	680.2	162.5	1740
Jan/90	3	473.4	545.2	86.67	1097

SNOW GEESE

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	1446	1503	0	3000
Nov/89	5	335.3	461.4	0	933.3
Dec/89	4	526.3	983.7	0	2000
Jan/90	3	1.557	2.696	0	4.67

TOTAL GEESE

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	1446	1503	0	3000
Nov/89	6	279.4	434.8	0	933.3
Dec/89	4	526.3	983.7	0	2000
Jan/90	3	1.557	2.696	0	4.67

SWANS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	0	0	0	0
Nov/89	6	7.333	7.281	0	18.33
Dec/89	4	24.5	17.6	9	49.33
Jan/90	3	36.56	41.03	8.67	83.67

WATERFOWL

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	3567	1855	2112	5655
Nov/89	6	941.6	953.5	50	2536
Dec/89	4	1351	1022	178.5	2537
Jan/90	3	511.4	588.7	95.33	1185

SHOREBIRDS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	205.5	356	0	616.6
Nov/89	6	3259	4941	0	10517
Dec/89	4	3396	3835	0	6767
Jan/90	3	611.2	918.1	0	1667

GULLS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	84.22	97.01	22	196
Nov/89	6	15.83	29.26	.33	75.33
Dec/89	4	70.66	70.51	.5	168.3
Jan/90	3	59.78	48.95	4.33	97

DIVERS (loons, grebes, cormorants)

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	.11	.1905	0	.33
Nov/89	6	.6667	.9177	0	2.33
Dec/89	4	.4175	.5006	0	1
Jan/90	3	.22	.1905	0	.33

TOTAL BIRDS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	3857	1587	2926	5690
Nov/89	6	4217	4326	620.6	10574
Dec/89	4	4818	4820	379	9267
Jan/90	3	1183	828.4	258.6	1859

Monthly mean number of birds recorded at Roberts Bank during 1989/90 aerial censuses. Calculated from daily mean numbers.

DABBLERS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	10957	2014	9353	13217
Nov/89	6	10344	3586	7148	16592
Dec/89	4	6879	2320	3705	9280
Jan/90	3	7819	1528	6533	9508

DIVING DUCKS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	238.9	385.2	0	683.3
Nov/89	6	236.3	229	20.33	550
Dec/89	4	114.6	205	0	421
Jan/90	3	14.45	13.47	0	26.67

TOTAL DUCKS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	11196	1924	9387	13217
Nov/89	6	10580	3780	7243	17065
Dec/89	4	6993	2453	3743	9701
Jan/90	3	7834	1541	6533	9535

SNOW GEESE

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	0	0	0	0
Nov/89	6	.055	.1347	0	.33
Dec/89	4	.0825	.165	0	.33
Jan/90	3	0	0	0	0

TOTAL

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	34	58.89	0	102
Nov/89	6	.055	.1347	0	.33
Dec/89	4	4.25	8.281	0	16.67
Jan/90	3	0	0	0	0

SWANS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	0	0	0	0
Nov/89	6	1.388	2.776	0	7
Dec/89	4	.0825	.165	0	.33
Jan/90	3	.2233	.3868	0	.67

WATERFOWL

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	11230	1876	9489	13217
Nov/89	6	10582	3782	7244	17072
Dec/89	4	6998	2453	3743	9701
Jan/90	3	7834	1541	6533	9536

SHOREBIRDS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	75.54	103.3	0	193.3
Nov/89	6	169.4	209.8	0	566.6
Dec/89	4	1508	2799	0	5700
Jan/90	3	1889	2009	0	4000

GULLS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	121.4	57.03	61	174.3
Nov/89	6	19.22	12.98	2	34
Dec/89	4	72.19	102.6	9.5	224.6
Jan/90	3	111.4	127.5	29	258.3

DIVERS (loons, grebes, cormorants)

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	0	0	0	0
Nov/89	6	2.667	3.062	0	7
Dec/89	4	.875	1.75	0	3.5
Jan/90	3	1.447	1.345	.67	3

TOTAL BIRDS

Month	No. of Counts	Mean	Std. Dev.	Minimum	Maximum
Oct/89	3	11427	1771	9856	13346
Nov/89	6	10775	3791	7254	17335
Dec/89	4	8579	3929	3756	13158
Jan/90	3	9836	856.3	9148	10795

APPENDIX 3

Z-test results of annual and monthly comparisons of dabbling ducks and gulls for the Fraser foreshore and Boundary Bay.

Z-test results comparing mean birds by month between years for dabblers and gulls on Boundary Bay and the Fraser foreshore.

Probability using a Z-test for differences between means can be expressed liberally as significant at the .05 level or conservatively, using Multiple Range tests, as .05/n, where n is the number of comparisons being made. For comparisons between 1989-90 and other years, significant differnces would be found at .05/3=.017 level, there being 3 other years of data for comparison.

Dabbling Ducks

Boundary Bay

October

		Probability	
	1966-74	1982-83	1983-84
1982-83	.019	-	
1983-84	.028	.378	-
1989-90	.450	.080	.234

November

		Probability	
	1966-74	1982-83	1983-84
1982-83	.872	-	
1983-84	.164	.271	-
1989-90	.016	.044	.138

December

		Probability	
	1966-74	1982-83	1983-84
1982-83	.516	-	
1983-84	.441	.337	-
1989-90	.638	.984	.352

January

		Probability	
	1966-74	1982-83	1983-84
1982-83	.193	-	
1983-84	.033	.857	-
1989-90	.022	.161	.327

Fraser Foreshore

October

		Probability	
	1966-74	1982-83	1983-84
1982-83	.976	-	
1983-84	<.001	.164	-
1989-90	.017	.347	.400

November

	Probability		
	1966-74	1982-83	1983-84
1982-83	.173	-	
1983-84	.057	.364	-
1989-90	.001	.001	.094

December

	Probability		
	1966-74	1982-83	1983-84
1982-83	.802	-	
1983-84	.004	.001	-
1989-90	<.001	<.001	.234

January

	Probability		
	1966-74	1982-83	1983-84
1982-83	.688	-	
1983-84	.934	.315	-
1989-90	.441	.161	.015

Gulls

Boundary Bay

October

	Probability	
	1982-83	1983-84
1983-84	.238	-
1989-90	.857	.246

November

	Probability	
	1982-83	1983-84
1983-84	.682	-
1989-90	.453	.342

December

	Probability	
	1982-83	1983-84
1983-84	.944	-
1989-90	.516	.435

January

	Probability	
	1982-83	1983-84
1983-84	.119	-
1989-90	.078	.834

Fraser Foreshore

October

	Probability	
	1982-83	1983-84
1983-84	<.001	-
1989-90	.033	.214

November

	Probability	
	1982-83	1983-84
1983-84	.896	-
1989-90	.429	.037

December

	Probability	
	1982-83	1983-84
1983-84	.440	-
1989-90	.161	.218

January

	Probability	
	1982-83	1983-84
1983-84	.258	-
1989-90	.326	.976